DOCUMENT RESUME

ED 063 723 24 EC 042 249

AUTHOR Simpson, D. Dwayne; Nelson, Arnold E.
TITLE Breathing Control and Attention Training: A Preliminary Study of a Psychophysiological Approach to Self-Control of Hyperactive Behavior in Children. Final Report.
INSTITUTION Texas Christian Univ., Fort Worth. Inst. of Behavioral Research.
SPONS AGENCY National Center for Educational Research and Development (DHEW/OE), Washington, D.C.
REPORT NO TR-72-5
BUREAU NO BR-1-F-080
PUB DATE Jun 72
CONTRACT OEC-6-71-0541(509)
NOTE 60p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Attention Span; *Behavior Change; *Exceptional Child Research; Feedback; *Hyperactivity; Learning Disabilities; Operant Conditioning; *Physiology; Psychology; Reinforcement

ABSTRACT

The present study was undertaken as a preliminary evaluation of a psychophysiological method for training children in the control of hyperactive behavior. The method involves breathing control and attention training which employs biofeedback and operant conditioning principles designed to help the child develop control over excessive and distracting motor behaviors and maintain attention in learning situations. Since breathing records are highly sensitive to numerous behaviors relevant to the desired behavior pattern in learning settings, the use of respiration as a focal behavior in the training procedures sharply reduce the number of simple motor behaviors requiring monitoring and reinforcement in comparison to the typical behavior modification program. Six children (age 6 to 8 years old) from a private school for children with learning disabilities participated in the study. Three were assigned to a group given the breathing control and attention training and three were assigned to a control group. Measures obtained before, during, and after training included respiration indices, performance, attention and vigilance test scores, and teacher ratings of classroom behaviors. The study was concluded to be successful. (Author)

ED 063723

BR 1-7-080
PA 24
NCERD
EC

FINAL REPORT

Project No. 1F080
Contract No. OEC-6-71-0541-(509)

D. Dwayne Simpson
Arnold E. Nelson
Institute of Behavioral Research
Texas Christian University
Fort Worth, Texas 76129

BREATHING CONTROL AND ATTENTION TRAINING: A PRELIMINARY STUDY OF A PSYCHOPHYSIOLOGICAL APPROACH TO SELF-CONTROL OF HYPERACTIVE BEHAVIOR IN CHILDREN

IBR Technical Report No. 72-5
June 1972

EC 042 249E

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Office of Education

National Center for Educational Research and Development
(Regional Research Program)

FINAL REPORT

Project No. 1F080
Contract No. OEC-6-71-0541-(509)

BREATHING CONTROL AND ATTENTION TRAINING: A PRELIMINARY STUDY OF A PSYCHOPHYSIOLOGICAL APPROACH TO SELF-CONTROL OF HYPERACTIVE BEHAVIOR IN CHILDREN

D. Dwayne Simpson
Arnold E. Nelson

Institute of Behavioral Research
Texas Christian University
Fort Worth, Texas 76129

June 1972

The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
National Center for Educational Research and Development
(Regional Research Program)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

ABSTRACT

Overt hyperactivity among elementary-school age children is a common problem faced by educators today. It has been estimated that four of every 100 children in this age range are hyperactive. Hyperkinetic children often have average or above-average intelligence but their excessive motor behavior and lack of attention restrict academic achievements, as well as disrupt normal classroom proceedings. Although the use of drug therapy has helped to deal with some of these problems, it is not effective for all children and it has not proven to be a complete or final solution to hyperkinesis.

The present study was undertaken as a preliminary evaluation of a psychophysiological method for training children in the control of hyperactive behavior. The method involves breathing control and attention training which employs biofeedback and operant conditioning principles designed to help the child develop control over excessive and distracting motor behaviors and maintain attention in learning situations. Since breathing records are highly sensitive to numerous behaviors relevant to the desired behavior pattern in learning settings, the use of respiration as a focal behavior in the training procedures sharply reduced the number of simple motor behaviors requiring monitoring and reinforcement in comparison to the typical behavior modification program.

Six children (age 6-8 years old) from a private school for children with learning disabilities participated in the study.

Three were assigned to a group given the breathing control and attention training and three were assigned to a control group. Measures obtained before, during, and after training included respiration indices, performance, and attention and vigilance test scores, and teacher ratings of classroom behaviors. The results of the study supported the feasibility of the training approach and provided important information relevant for future refinements in training and evaluation procedures.

ACKNOWLEDGMENTS

Sincere appreciation is expressed to Dr. Henry Patterson, Principal, Mrs. Laura Lee Crane, Assistant Principal, and other faculty of Starpoint School for their cooperation and valuable suggestions during the course of this study.

Grateful acknowledgments are also extended to Miss Marcia McMurry and Mr. Dick Harris for laboratory assistance, to Mr. Kenneth Gillaspy for data collection, and to Mrs. Louise McQuade for secretarial assistance. Drs. Robert G. Demaree and S. B. Sells provided valuable suggestions for the direction of the research and the preparation of this report.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	ii
LIST OF TABLES	iv
LIST OF FIGURES	v
INTRODUCTION	1
RATIONALE FOR THE BREATHING CONTROL AND ATTENTION TRAINING	8
METHOD	11
RESULTS	25
DISCUSSION	41
CONCLUSIONS	48
REFERENCES	49
APPENDIX	51

LIST OF TABLES

Table		Page
1	Pre-test, Post-test, and Change (Δ) in Attention Measures for Proportion of Items Correct	38
2	Pre-test, Post-test, and Change (Δ) in WISC Scaled Scores	40

LIST OF FIGURES

Figure		Page
1	Respiration tracking error for Group E during training Sessions 1-11	26
2	Mean peak-to-peak interval (PP) for each S during pre-tests and post-tests	28
3	Peak-to-peak variability (PP-V) for each S during pre-tests and post-tests	29
4	Inspiration-amplitude variability (IA-V) for each S during pre-tests and post-tests	31
5	Mean respiration record irregularities (RI) per minute for each S during pre-tests and post-tests	32
6	Mean respiration peak-to-peak intervals (PP) for each S during story-reading periods	33
7	Mean respiration peak-to-peak variability (PP-V) for each S during story-reading periods	34
8	Mean inspiration-amplitude variability (IA-V) for each S during story-reading periods	35
9	Mean respiration record irregularities (RI) per minute for each S during story-reading periods	36
10	Mean ratings of hyperactivity by teachers before, during, and after training	42
11	Mean ratings of inattentiveness by teachers before, during, and after training	43
12	Mean ratings of distractibility by teachers before, during and after training	44

Introduction

The problems of hyperactive (or hyperkinetic) children are well known and create one of the most difficult situations faced by teachers, particularly at the elementary school level. The children typically perform poorly and create frequent interruptions of regular class activities. Even more frustrating for the teacher and parents is the fact that the hyperkinetic child is often regarded as being intellectually capable of doing satisfactory school work, but excessive motor behavior, distractibility, and lack of attention precludes academic success. Millichap (1968) provides some insight to the scope of the problem associated with overt hyperactivity in children.

> Hyperkinesis is a frequent behavioral disorder in children and adolescents, affecting boys more commonly than girls. It has been estimated that four out of every 100 grade school children and 40% of school children referred to mental health clinics because of behavioral disturbances are hyperactive. They have short attention and concentration spans, and their actions are irrelevant and without clear direction, focus, or object. Restlessness, impulsiveness, and garrulousness disrupt discipline in the home and in the classroom. Thus children with these behavioral characteristics are often regarded by those with whom they come in contact as spoiled, ill-mannered, queer, and uncoordinated. Although the hyperkinetic child may be mentally retarded, he is often of average or above-average intelligence but below average in schoolwork performance because of poor concentration and impaired motor, memory, and speech functions. (p. 1527).

The definition and description of the hyperactivity syndrome, however, lacks in precision and in the specification of the defining parameters. The behavior has typically been encompassed by terms such as "hyperkinetic behavior disturbance," "minimal brain

dysfunction," "learning disability," and many others. Clements (1966) has noted 38 such terms used in the literature in reference to various learning problems in children. Part of the confusion arises from the fact that children often have special learning or reading disabilities in addition to the major symptoms of hyperactivity and there is a confounding of behavioral, psychological, and medical-neurological conditions.

The most obvious symptoms of hyperkinetic disorders are "an increase of purposeless physical activity and a significantly impaired span of focused attention" (Freedman, 1971). Furthermore, Freedman states "In its clear-cut form, the overt hyperactivity is not simply a matter of degree but of quality. The physical activity appears driven ... so that the activity is beyond the child's control, as compared to other children. The child is distracted, racing from one idea and interest to another, but unable to focus attention." In a review of the literature of research concerning hyperactive children, Keogh (1971) also notes the qualitative distinction of motor activity in hyperkinesis and describes it as "situationally and socially inappropriate." Thus, the qualitative aspects of the excessive motor behavior appear to be as important as the quantitative ones.

The causes of hyperactivity have been ascribed to various biological, psychological, social, and environmental factors. As Freedman (1971) indicates, however, so little is known in this regard that it is impossible to even speculate about original causes. Keogh (1971) concludes that evidence has shown that hyperactivity is by no means consistently related to cerebral

dysfunction and, furthermore, that it is unclear whether deficits of attention, perceptual disorganization, distractibility and related symptoms should be considered as defining parameters or as correlates of hyperactivity. Due to the lack of information regarding causes and the complex nature of symptoms and their interactions, the development of diagnostic procedures have typically included physical, neurological, social, behavioral, psychological, and educational evaluations of children with learning problems (Clements, 1966; Myklebust and Boshes, 1969).

Treatment programs. Since children afflicted with hyperkinetic disorders are generally of normal or superior intelligence (Freedman, 1971; Millichap, 1968), it is particularly important that treatment programs be developed to aid them toward effective interaction with their environment. The disruption caused by these children in the typical classroom setting and the learning difficulties that they exhibit in school cause many problems.

The two general treatment approaches most frequently employed can be classified as drug therapy and behavior modification. Drug therapy (Haring, 1969; Millichap, 1968; Millichap, Aymat, Sturgis, Larsen & Egan, 1968; Wunderlich, 1970) has improved the management of hyperkinetic and perceptually handicapped children and has led to small but significant improvements in the learning achievements of these children (Millichap et al., 1968). Nevertheless, these children often continue to exhibit behavior problems in the average classroom situation and do not respond well to the teaching methods used in that setting. The drugs aid in alleviating much of the hyperactive behavior but poor concentration, fidgeting, and short attention spans still cause difficulties in learning activities.

While the practice of drug therapy has grown considerably during recent years, it is not regarded as the only or ideal method of treatment. For the present, drug medication represents a convenient but imperfect alternative that is frequently selected as a treatment modality. Drug therapy is not equally effective with all children, however, and the optimal types and dosages of drug differ among children. More importantly, there are problems with this treatment method arising from questions concerning the long-term physiological and psychological effects of prolonged drug therapy which have not been answered.

The other popular treatment approach that has received much attention in recent years and which offers considerable promise is referred to as behavior modification. This approach commonly involves an operant conditioning technique by which desirable behavior is conditioned or "shaped" and undesirable behavior is eliminated from behavior patterns through the programmed use of reinforcements (Skinner, 1963; Grossberg, 1964). The technique has been employed with considerable success in a wide variety of situations including the treatment of children with learning disabilities. This method seeks to improve attention and performance through the utilization of external reinforcement according to a prearranged schedule. The rationale is to provide the child with reinforcement for relatively small segments of behavior in which appropriate responses are made which are within the child's capabilities. Once the child succeeds in the simplified setting and is rewarded for it, the probability is theoretically increased that the appropriate behaviors elicited will recur in the future.

The reinforcements are gradually shifted to encompass broader segments of behavior.

Several types of token reinforcements, such as toys and candy, have been used with success. In a study of first and second grade children "selected on the basis of their inappropriate, inattentive behavior in their classroom," Johnson (1969) awarded points for performance of a symbol-discrimination task. The points could later be redeemed for candy or toys as rewards. The results revealed that performance on this attention-demanding task was maintained at a higher level with reinforcement than with no reinforcement. Walken (1969) has likewise reported that attending behavior and learning rate were significantly improved through the use of token reinforcement with "behaviorally disturbed" children. These procedures have also been found to be effective in correcting problem behavior of children in home settings (Christophersen & Arnold, 1971; Hall, Axelrod, Tyler, Grief, Jones, & Robertson, 1971). O'Leary and Drabman (1971) have reviewed the literature on token reinforcement programs used in the classroom and noted their effectiveness in improving social and academic behavior in diverse child populations.

One of the most interesting studies using behavior modification techniques was reported by Patterson, Jones, Whittier and Wright (1965). The report described the procedures used in the conditioning of attending behavior in a brain-injured hyperactive boy. Several weeks of baseline observations of two hyperactive children (one designated experimental and one control) provided data on frequency of occurrence of high rate responses such as walking, talking, distraction, and "wiggling." Conditioning

procedures were then initiated for the experimental subject in an effort to change his classroom behavior. The procedures involved auditory stimuli which represented token reinforcements (pennies, candy, and toys) contingent upon the behaviors exhibited. Reinforcement was given following ten-second time intervals in which non-attending behaviors were absent. Involvement by the experimental subject's classmates was also introduced by allowing him to "earn" rewards for them as well as himself. In other words, by suppressing non-attending behaviors he earned token rewards for himself and others, in which case he typically received social reinforcement or approval from his peers.

The results revealed that the experimental subject showed a marked improvement in attending behavior as opposed to the control subject. It should be noted, however, that the control subject did not participate in any conditioning procedures and that the observers who rated the children's behavior were aware of the identity of the experimental subject. This study would have been improved through the use of "blind" observers and of another control subject given specialized treatment similar to that of the experimental subject. In spite of these limitations and the use of only one experimental subject, the results merit close study.

Similar procedures were used (Cobb, Ray, & Patterson, 1971) in an extension of this research, involving seven hyperaggressive boys in a classroom setting. Attending behavior was improved in the children to the level of that of average male peers, and the gains were maintained during the five-month follow-up period of observation.

The use of behavior modification techniques with children showing behavior problems has been very encouraging in general. While they have been used successfully in the control of neurotic behaviors (Ullmann & Krasner, 1965), recent research has shown that it may be one of the most important and beneficial approaches for dealing with hyperkinetic behavior in children. Further development and refinement of the behavior modification approach, using innovative techniques adapted to special problems, are needed in order to exploit its possibilities.

Objectives of the present research. The purpose of this study was to provide a preliminary evaluation of a psychophysiological approach for training overtly hyperactive children to control excessive and extraneous motor activity and to maintain attending behavior. The training procedure is based on operant conditioning principles and is designed to help the child develop control over his breathing pattern and thereby distracting motor behaviors, such as fidgeting and squirming. As a result, he is expected to demonstrate increased capacity for attention in learning situations. The training is composed of a programmed schedule of token reinforcements, directed toward the establishment of consistent and well-regulated breathing patterns.

The use of respiration as the focal behavior to be controlled, aided by a visual feedback display of the recordings, represents a unique feature of the training procedure and is a primary basis for the advantages that it appears to offer over other methods. Respiration recordings serve as a sensitive index of gross body movement and motor activity. By controlling ones own breathing

pattern, as displayed in respiration recordings so that it is appropriately moderated in rate and amplitude characteristics, a substantial degree of motor control is established. The reduction of disruptive motor behavior results in t. .stablishment of a behavior pattern considered to be more conducive both to attention and to information intake.

Rationale for the Breathing Control and Attention Training

The logic for the training method is presented in three parts. The first part discusses the use of respiration as the focal behavior in the training procedure. Next, the relationship of the training procedure to previous methods is examined. The final section presents the theoretical basis for the training.

Respiration as a focal behavior in the training procedures. Breathing behavior is very sensitive and highly related to other bodily activities, especially gross body movements such as those so often displayed by hyperactive children. While breathing is controlled automatically to a large degree by the respiratory centers in the upper brain stem, there is still a great deal of voluntary control over this function. Thus, by learning to control breathing so that recordings are regular in rate and amplitude, as well as free of movement artifacts, the child is able to acquire self-control that extends to the control of disruptive motor behaviors. The procedure is simple and requires the child only to focus on essentially one behavior instead of many. Also, visual feedback of the behavior is easily accomplished for the purpose of initial training.

Regularity of breathing is also an important characteristic of attending behavior. Woodworth and Schlosberg (1954) have noted, for instance, that breathing tends to become regular as well as more shallow and quickened during attention. The regulation of breathing during attention appears to be a part of a general behavior pattern involving few gross body movements, focused perceptual and cognitive processing systems, and altered physiological states. Maintenance of regulated breathing, therefore, should promote a behavior profile maximally receptive to environmental stimuli and maximally effective in interpreting and processing information.

The relationship of the training procedures to previous approaches. In a behavior modification program, the choice of specific behaviors to be shaped or altered is very important. With hyperkinetic children, the focus generally has been upon the excessive motor activity. Thus, investigators have oriented their training procedures toward eliminating specific motor behaviors with the hope that improvements would result in attention and performance. In order for this particular approach to be successful, however, each specific behavior to be controlled by the child must be identified, monitored, and reinforced appropriately by the investigator. It is therefore necessary to use trained observers to watch the child during training and have them complete behavior checklists or rating scales for the selected behaviors of interest. When the number of behaviors being rated is large, as is usually the case in studies with hyperactive children, the task of effectively monitoring and reinforcing them becomes formidable.

Likewise, when the number of specific behaviors to be controlled becomes more numerous, the training can be assumed to become more difficult for the child.

Many of the training programs have also focused only on eliminating undesirable behaviors, such as motor activity, without reinforcement directed at establishing desirable behavior, such as attending. While the elimination of excessive motor activity may increase the probability that attending behavior will be exhibited by the child, the relationship certainly cannot be considered to be causal or perfect. The child may learn to inhibit motor behavior but still fail to attend to appropriate stimuli. Reinforcements should therefore be based upon the elimination of undesirable behaviors as well as upon the acquisition of desirable ones.

A solution to the problems of behavior modification programs discussed above would be to reduce the number of behaviors to be controlled to a minimum in order to simplify the training procedures for both the investigator and the child being trained. To achieve this requires the selection of a "higher-order" behavior, the control of which indirectly affects a complex of other "lower-order" behaviors of interest to the investigator. In other words, the control of a single higher-order behavior would have the effect of indirectly controlling several lower-order behaviors. Respiration fits the qualifications as a higher-order behavior and has in effect been used as such for many years in the practice of yoga and Zen meditation. Similarly, breathing control is used as an exercise to aid in achieving physical relaxation in autogenic relaxation training (Schultz & Luthe, 1959).

A theoretical basis for the training procedure. Keogh (1971) has reviewed research with hyperactive children and offered three hypotheses regarding the basis for learning difficulties by these children. The hypotheses are not exhaustive or necessarily independent, but they do represent three of the more common viewpoints concerning this matter. The first represents the medical-neurological syndrome explanation; that is, learning problems are perceived as being caused by neurological impairment. The second hypothesis reflects the view that increased motor activity is the major obstacle to learning, due to the disruption of attention and prevention of accurate intake of information. The third suggests that the learning problems are a function of hasty, impulsive decisions in learning situations.

The third hypothesis concerning the decision process is probably the least supported. The other two appear to be more widely accepted, particularly the second one proposing the disruption of information acquisition. The viewpoint that excessive, extraneous movement interrupts the learning process is also the one that is most susceptible to remediation and therapeutic programs. The success achieved by previous studies of behavioral management programs aimed at decreasing motor activity provides indirect support for this hypothesis. The rationale of the presently proposed study is also based essentially on this viewpoint.

Method

Subjects

Six male children (age 6-8 yrs. old) from Starpoint School participated in the study. Starpoint School is on the Texas

Christian University campus and is a school for children with learning disabilities. The school's screening and testing records indicated that the children each had average or above average intelligence scores and there was no evidence of neurological impairment. The children were hyperactive and four of the six were on prescribed medication (ritalin or dexedrine) during all or part of the duration of the study. There was no experimental intervention of the medication program for the purpose of the present study. Three children were randomly assigned to an experimental training group and three were assigned to a control group. There were two children in each group who received medication.

Apparatus

Testing and training were conducted in the Biopsychology Laboratory of the Institute of Behavioral Research at Texas Christian University. The room used was decorated to resemble classrooms at Starpoint School. Located in one end of the room were two training cubicles, separated by partitions, and each was equipped with a desk, an oscilloscopic display, and a response key. The display and response key were both removed from the room later in the study as a part of the training sequence. The room was also equipped with a teacher's desk, projection screen, a reward dispenser in one of the training cubicles, and a closed-circuit TV and microphone for monitoring purposes.

Located adjacent to the training room was the instrumentation chamber which had visual access to the training area via one-way glass, in addition to the closed-circuit TV system. All

recording and experimental programming equipment were situated in this chamber. An E&M Physiograph-Six and telemetry equipment were employed in the recording of respiration (impedance pneumography). Recordings could be obtained simultaneously from two children. Silver-disc sensors and a miniature transmitter were attached to the chest and the shirt was replaced over them. Other instruments located in the chamber for stimulus programming and presentation included slide and movie projectors, an analog computer, timers, counters, a tone generator, TV and oscilloscopic display monitors, a tape recorder, and a relay-logic network.

Procedure

The study consisted of three phases, including pre-testing, training, and post-testing. The childrens' participation in the study was a regularly scheduled activity which was integrated with the program at Starpoint School. The duration of the testing and training phases was three and one-half months (the fall semester of the school term), during which time the children participated in approximately two one-hour sessions per week. The sessions were conducted with children individually, in pairs, and in groups. Each of the three phases of the study will be described below in more detail.

Pre-testing. Two group sessions were conducted initially for the purpose of introducing the children to the training program and its environment. Respiration recording sensors and transmitters were worn by the children and sample trials from four attention tests (described below) were given.

The pre-testing was conducted in three sessions of about one-half hour each. The children were tested individually. Four attention or vigilance tests were administered in two of the sessions, during which time respiration recordings were obtained. Each test required approximately 8 min. and there was a 2-min. rest period between the two tests in each session. In the third session, the Wechsler Intelligence Scale for Children was administered. A discussion of the five pre-tests follows.

A. Visual discrimination test (VDT) -- This test was a modification of the Design Recall and Matching Familiar Figures tests devised by Kagen (1965). It was chosen to measure vigilance, discrimination and short-term memory abilities. Fifty picture stimuli of familiar objects were taken from various levels and subsections of the SRA "Learning to Think" series. Four practice items were administered first, each representative of the matching concepts (e.g., size, shape, content, identicality). The 50 items were arranged in ascending order of difficulty based on judgment by the first-grade teacher at Starpoint School.

The Ss were shown the primary stimulus for approximately 5 sec., followed by presentation of four to six choice items all contained on one card. The S was instructed to point to the item most compatible with the primary stimulus ("which one goes with it"). An experimenter (E) observed the response via the one-way window. If the S failed to make a response within 10-15 sec., an omission was recorded. Only one response was permitted and the subsequent test item was then presented. Results were tabulated in terms of correct, incorrect, and omitted answers.

B. Visual vigilance test (VVT) -- This test was adapted from the Card Test devised by Schulman, Kasper, and Throne (1965). It was considered to be a good measure of ability to maintain attention to repetitious visual stimuli and discriminate between the alternatives. The test involved a sequence of 280 slides, 90% of which were of the word "bike" and 10% of the word "boat." The order of the slides was randomized. A telegraph key was mounted on the S's desk, and he was instructed to momentarily depress it when the word "boat" appeared on the screen. Ten practice slides were presented to insure that the S understood his task. Failure to correctly discriminate any of the practice items required practice repitition until the S could respond correctly in each instance.

The 280 slides were presented at 1-sec. interstimulus intervals, with each slide illuminated for .5 sec. The responses were recorded as correct, incorrect, and omitted.

C. Auditory vigilance test (AVT) -- This test was a modification of the Tone Test reported by Schulman et al. (1965). It was chosen as an auditory version of the visual test for measurement of attention and discrimination abilities. Two hundred tones, of which 10% were 800 Hz. and 90% were 1000 Hz., were randomly arranged and recorded on tape. A telegraph key was attached to the S's desk, and he was instructed to depress the key when hearing the 800 Hz. (low) tone. The tones were presented through a speaker located near the S. Ten practice tones were administered first, and the test did not begin until the S responded satisfactorily to all of the tones.

The 200 stimuli were presented for 1 sec. each with interstimulus intervals of 1.5 sec. Responses were scored as correct, incorrect, and omitted.

D. Light detection test (LDT) -- This test was selected for its visual attention and discrimination qualities. A display panel containing a red and green light was positioned in front of the S, and two telegraph keys were attached to the desk top. The S was instructed to depress one key at each onset of the red light and the other key at each onset of the green light. Ten practice trials were given to insure understanding of the instructions.

A double-tape programmer was used to administer 25 red and 25 green stimuli, arranged in random order. Each stimulus was .5 sec. in length, with an interstimulus interval ranging between 6 to 15 sec. Scores were determined for the number of correct, incorrect, and omitted responses.

E. Wechsler Intelligence Scale for Children (WISC) -- Five subtests of the WISC were administered and included digit span, picture arrangement, block design, coding (A), and mazes. These were chosen for measurement of attention, comprehension of common situations, pattern perception and ability to shift attention, short term memory and association, and planning ability. Results were tabulated in the form of scaled scores.

Training. Upon completion of the pre-testing phase, the Ss were assigned randomly to either the experimental (E) training group or the control (C) group. The training phase lasted approximately 11 weeks. The nature of the training procedures for Group

E and Group C will be described in the next two sections, and they will be followed by a description of the overall schedule of training activities and the generalization training.

A. Group E -- The training in this group was directed toward training the S to attend to and control characteristics of his respiration recordings. This was carried out using principles of operant conditioning in conjunction with a feedback display to the S of his respiration recording. That is, "shaping" procedures were employed whereby periods of regulated breathing were reinforced with tokens, which were later traded in by the child for candy or money.

The feedback was presented on an oscilloscopic display housed and located in the training cubicle and immediately in front of the S. In the display, a vertically displaced beam (controlled to a range of approximately 3 cm.) corresponded to the inhalation and exhalation of the breathing recordings being obtained on the physiograph in the instrumentation chamber. The display also revealed a second, but distinctive, beam which represented a "target," according to which the S was to pattern his own breathing. The task, in effect, was a "pursuit tracking" task in which the S learned to maintain the beam under his control (via respiration) coincident with the target beam.

The target beam was a signal, similar in form to the normal respiration waveform, which was generated by an analog computer and was adjustable in terms of amplitude, rate, and slope characteristics. Displacement of the target beam was adjusted for each S individually so that it was representative of his average

respiration rate and pattern characteristics. The target, therefore, served as a sample respiration pattern for each S, representing the same essential characteristics as shown in his own breathing pattern, except that the target exhibited maximum regularity in rate, amplitude, and pattern of breathing. To the extent that the S was able to maintain breathing which was comparable to the target pattern, he was given appropriate reinforcements.

Reinforcements given to the S were based on the discrepancy between his breathing pattern and the target pattern. The amount of discrepancy was measured (using the analog computer) whereby absolute difference scores between the beams were determined in analog form and accumulated (using an integrator) during each discrete trial period. Error score calibration was such that a difference of 1 cm. between the beams for a 1-sec. interval resulted in an error score of 1 unit. During any given interval, therefore, a measure of tracking error was available for use in determining reinforcements. The reinforcements were small plastic beads which were dispensed into a clear plastic container located near the S.

The training was conducted in discrete trial periods, with the S being reinforced for restricting the amount of error between his breathing recording and the target pattern. The periods were accompanied by the illumination of a small green lamp (located on the display housing) which served as a cue signal for the S. The oscilloscopic feedback display was operative only during the trial periods and rewards were dispensed at the conclusion of

each period. Each trial period ranged from 10 sec. to 1 min. in length.

The length of the training periods and reinforcement schedules were determined individually for each child on each occasion, using past behavior as the criterion for judging current performance. Brief intervals of time intervened between training periods, and training sessions typically included a game period or time for a story to be read.

B. Group C -- The training cubicle for Group C was essentially the same as that for Group E, and training for the two groups was conducted simultaneously. Subjects in Group C, however, did not receive instructions and training in breathing control, and were not provided with feedback of their own respiration records. Instead, the display for Ss in Group C was exactly the same as that for Ss in Group E. In other words, the feedback display used in the training of a Group E S was displayed simultaneously for training of a Group C S. The instructions to Group C, however, were to observe the display closely and to press a key on the desk when the two display beams were coincident. Thus, the training task for Group C was essentially a vigilance task based upon the same display used by Group E for learning breathing control.

Reinforcements for Group C were determined on the basis of general performance and conduct during the session. Group C received beads in a plastic container at the conclusion of the session, and at that time the Ss from both groups counted the number of beads they were awarded and traded them in for rewards.

C. Training schedule -- The first training session for each S was given individually in which preliminary instructions and training appropriate for his group were provided. Beginning with the next session, training was conducted for one S from each group, simultaneously.

Initially, sessions involved only one S from each group. The Ss were brought to the training room, sensors were attached, and they were seated in their respective training cubicles. Actual training time during the session was approximately 30-40 min. and the experimenter-teacher was always present at her desk. Respiration was recorded continuously from both Ss throughout the session. Mid-way through the session, there was a 5-min. break (without reinforcements) for a game or story-reading. The story-reading was scheduled so that respiration recordings could be obtained during this period, usually once a week, from each S throughout the weeks of training. Respiration records during the game periods were disregarded.

The beads earned by each S were traded for rewards at the end of each session. A variety of candies were used as rewards during the training phase, including M&Ms, Life Savers, and similar bite-size candies. The S could select from a variety of candies and the amount was dependent upon the number of beads earned during the session. The candy was then eaten before returning to Starpoint School.

After each S received eight training sessions (two per week) as described above, the training procedures were gradually extended to other stimulus settings in an attempt to transfer the

effects of breathing control and attention training to other situations, particularly school settings.

The first step was to introduce social factors into the training situation by including all Ss from both groups in the same training session. The groups were seated in their respective training cubicles and while one S from each group participated in training, the other two (seated immediately behind the training S) observed. The training procedures per se remained essentially the same as in previous sessions, although the presence of other children added a new dimension to the setting. During the session, the training was rotated from one S to another until each of the three Ss in both groups completed a training period. The training period for each S lasted approximately 20 min. After each S's training period, the number of beads earned by the S was recorded on a chart in the room, and recording sensors were transferred to another S. A 5-min. break was also included for a game or story-reading. At the end of the day's session, each S received rewards for the total number of beads he had accumulated, which reflected the number earned during his training period minus any that were "taken away" by the experimenter-teacher during the remainder of the session for misconduct or excessive "acting out."

Three sessions were conducted in which the training was carried out in the group setting as described above. Following these sessions, the training procedures were progressively altered on each occasion. The group setting was maintained but the emphasis of the training was changed in an attempt to maximize the

transfer of training effects. The next section outlines the major steps taken in the generalization training.

D. Generalization training -- The overall objective of the generalization training was to extend the practice of breathing control to other situations, especially those having to do with academic performance and attention maintenance. During these sessions, stimuli used in the training cubicle, such as the feedback display and cue light, were eventually eliminated and the setting gradually approximated regular classroom activities. Respiration recordings were continued throughout the sessions and the Ss in each group alternated in training periods, as they did in the previous sessions.

In the initial generalization sessions, Group E was given training in the regulation of breathing without the aid of the target pattern. That is, reinforcement was provided periodically, contingent upon regulated breathing records, free of movement artifacts. Later, respiration feedback was eliminated from the training and subsequently, sessions included presentations of travel slides, movies, academic lessons presented by the experimenter-teacher, and a lesson presented by the regular first-grade instructor from Starpoint School. Use of the training cubicles was eliminated in the final sessions such that Ss from both groups were mixed together in the seating arrangements.

Throughout the initial generalization sessions (until respiration feedback to Group E was eliminated from training) Group C continued to perform a vigilance task based on the feedback display and reinforcements continued to be awarded at the end of each

training period. The reinforcements were comparable in number to those given to Ss in Group E and were based in part upon a general evaluation by the experimenters of performance and behavior control.

To increase group awareness and social facilitation within each group during generalization training, rewards for each S were based upon the combined beads earned by the members of his group. Money was also used as rewards during the concluding sessions since this was the mode of reinforcement currently in use at Starpoint School. Thus, pennies were awarded on the basis of accumulated beads across sessions.

Post-testing. The post-testing phase was a replication of the tests conducted during pre-testing. The procedures were the same for both test phases.

Data Collection

A variety of measures were obtained for evaluating the differential effects of the training procedures. They are categorized as respiration records measures, performance scores, and behavior ratings and are discussed separately.

Respiration measures. Four respiration measures were obtained during the first, middle, and last minutes of the pre- and post-tests for the VVT, AVT, and LDT. For each test, data were combined for the three 1-min. measurement periods. The respiration measures were not determined during the pre- and post-tests for the VDT because of arm and hand movements demanded by the task. The respiration measures were also obtained for the combined data of the

first, third, and fifth minutes of each of the reading periods presented throughout the training phase. The measures obtained were as follows.

A. Peak-to-peak interval (PP) -- This measure represented the average distance (in mm., where 5 mm. equaled a time interval of 1 sec.) between successive inhalation peaks across the three 1-min. respiration records.

B. Peak-to-peak variability (PP-V) -- The standard deviation of the peak-to-peak distance scores across the three 1-min. respiration records was used as a measure of the variability of breathing periodicity.

C. Inspiration-amplitude variability (IA-V) -- A measure of fluctuation in breathing depth across the three 1-min. respiration records was obtained by determining the standard deviation of scores for the height of the inhalation phases in the records (measured in mm. from the exhalation trough to the inhalation peak). Recording amplification was adjusted so that the average height of inhalation-amplitude was standardized for each S to equal 15 mm.

D. Record irregularities (RI) -- A measure of recording artifacts resulting from gross body movement was also obtained. Three judges, working independently, counted irregularities during each 1-min. respiration record. A record irregularity (RI) was defined as a sharp, vertical shift in the waveform of at least 1 cm. in height or an abrupt change in the depth of the waveform of at least twice its normal amplitude. Scores from the three judges for each 1-min. record were combined and the average was

used as the RI measure. A mean RI for each test was then determined on the basis of the three 1-min. RI scores for the test.

Performance scores. Performance scores were obtained in pre- and post-testing for the attention and vigilance tests and the WISC as described previously.

Behavior ratings. The Student Behavior Scale was developed to obtain ratings of classroom behavior of the children by teachers. The instrument consisted of 45 items and each item was scored on a 7-point scale. Items referred to general behavior, classroom behavior, group behavior, and academic behavior. A sample copy of the scale can be found in Appendix A. It was completed by two of the Starpoint School instructors every other week throughout the duration of the study. The instructors both worked closely with the children in the classroom and were not informed of the group memberships during training.

Results

The results will be presented separately for the respiration measures, performance scores, and behavior ratings. Due to the small number of Ss involved in the study, the statistics are descriptive in nature.

Respiration Measures

Training. The performances of the three Ss in Group E in respiration tracking during Sessions 1-11 are shown in Figure 1. The figure represents the average units of tracking error per minute for each S across training periods within sessions. The units of tracking error reflect the accumulated discrepancy in

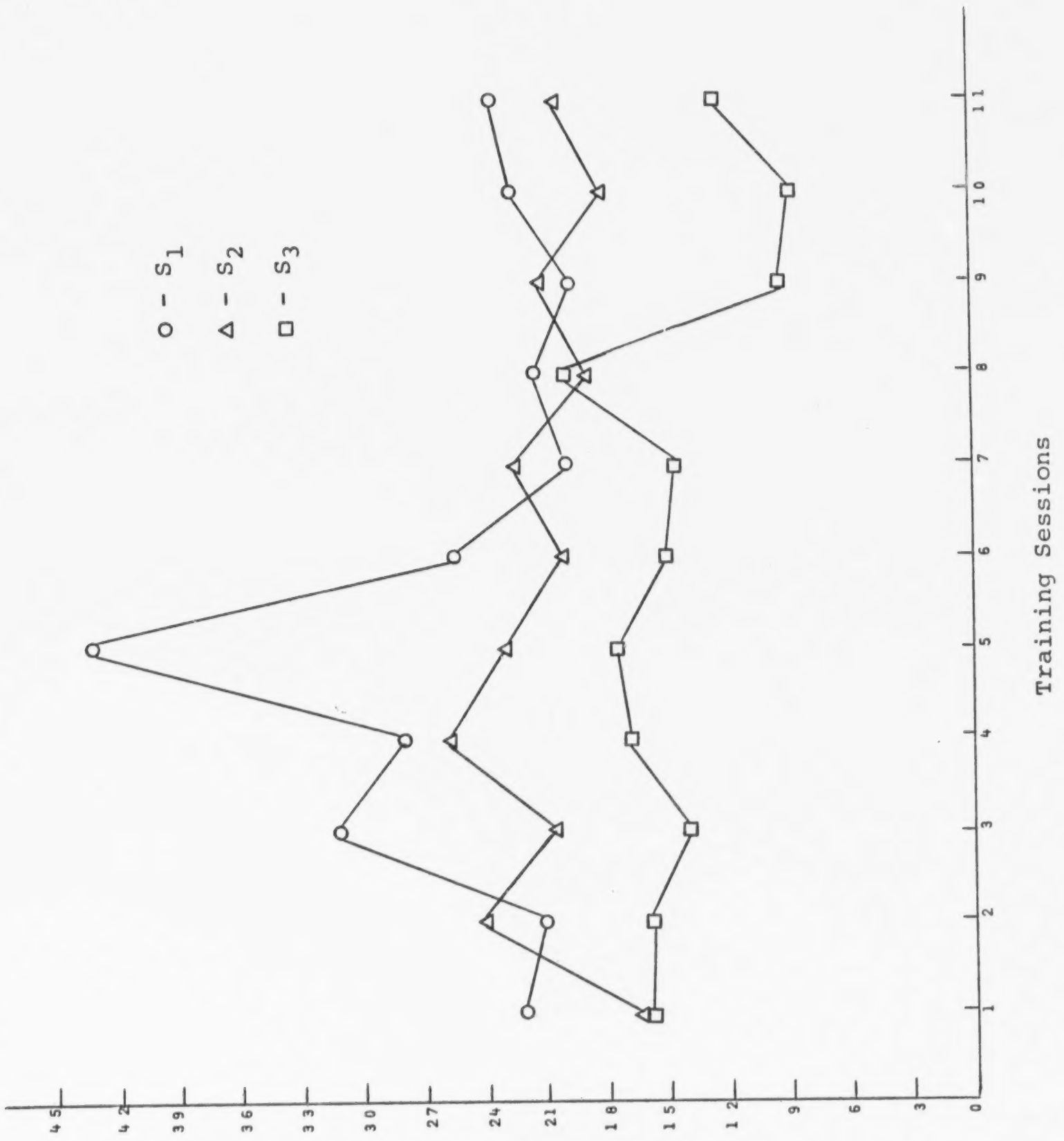


Fig. 1. Respiration tracking error for Group E during training Sessions 1-11.

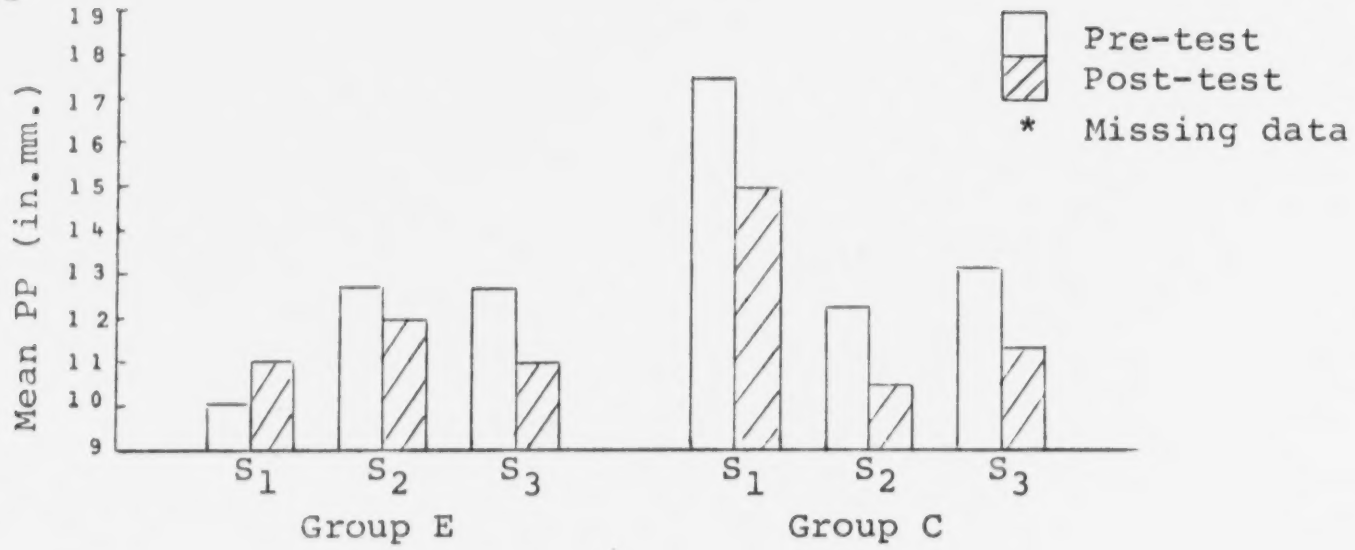
distance between the S's respiration-controlled beam and the target beam, where 1 cm. difference between beams for 1 sec. equals 1 error unit. The profiles reveal little consistent change in performance over the sessions. It should be noted, however, that the tracking periods for the S in each session were made successively more difficult by increasing the length of the time intervals for respiration tracking. Furthermore, the figure illustrates the superiority of S_3 over S_1 and S_2 in tracking performance and the additional improvement in his performance in Sessions 9, 10, and 11, in which group training was introduced.

The number of reinforcement beads earned by Ss during the 23 sessions of the training phase ranged from 1 to 50 per session. The average number of reinforcements per session for Ss in Group E was 18.0 beads (S_1 = 14.2, S_2 = 17.5, S_3 = 22.3) and for Group C, 19.3 beads (S_1 = 14.3, S_2 = 21.4, S_3 = 22.3). Thus, the number of reinforcements were very similar for each group.

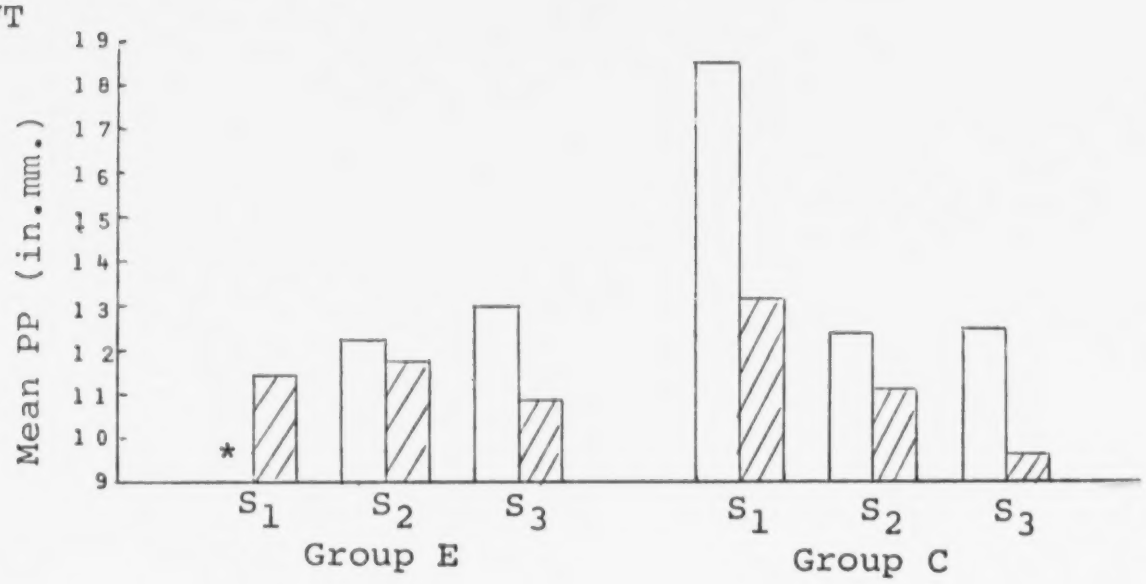
Pre-tests and post-tests. Figures 2 and 3 present the mean respiratory peak-to-peak interval (PP) and interval variability (PP-V), respectively, for each S during the light detection test (LDT), visual vigilance test (VVT), and auditory vigilance test (AVT). For S_1 of Group E, however, the pre-test for VVT and the pre- and post-tests for AVT were aborted because of excessive hyperactivity and inability to complete the tests, and all measures for the S on those tests are therefore incomplete.

It is observed in Figure 2 that both groups tended to show slightly shorter respiratory intervals (that is, more rapid breathing) during post-tests as compared to pre-tests. Measures for

A - LDT



B - VVT



C - AVT

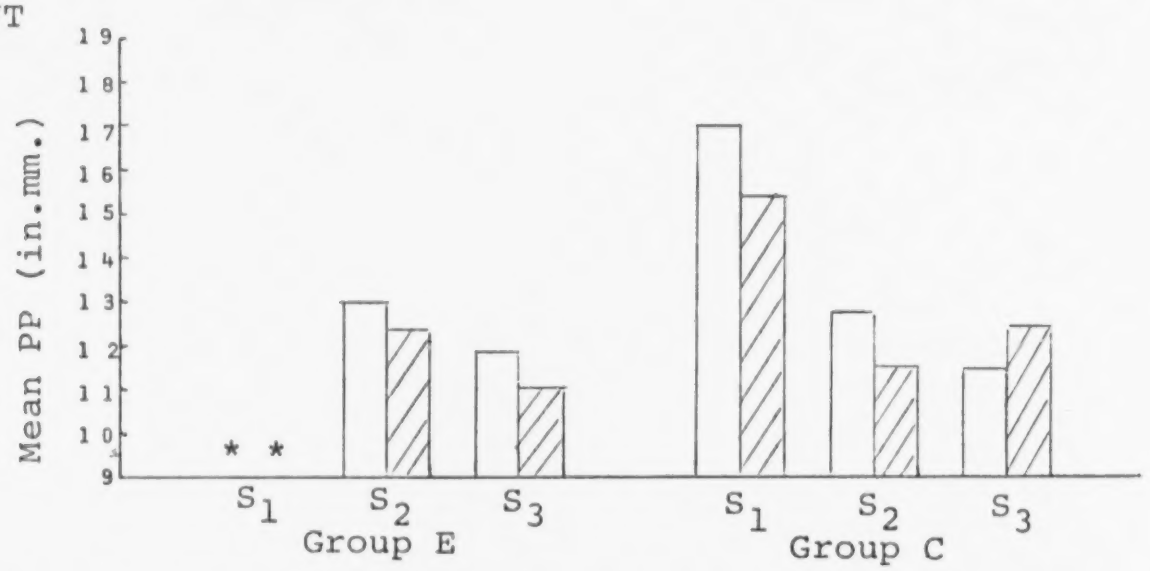
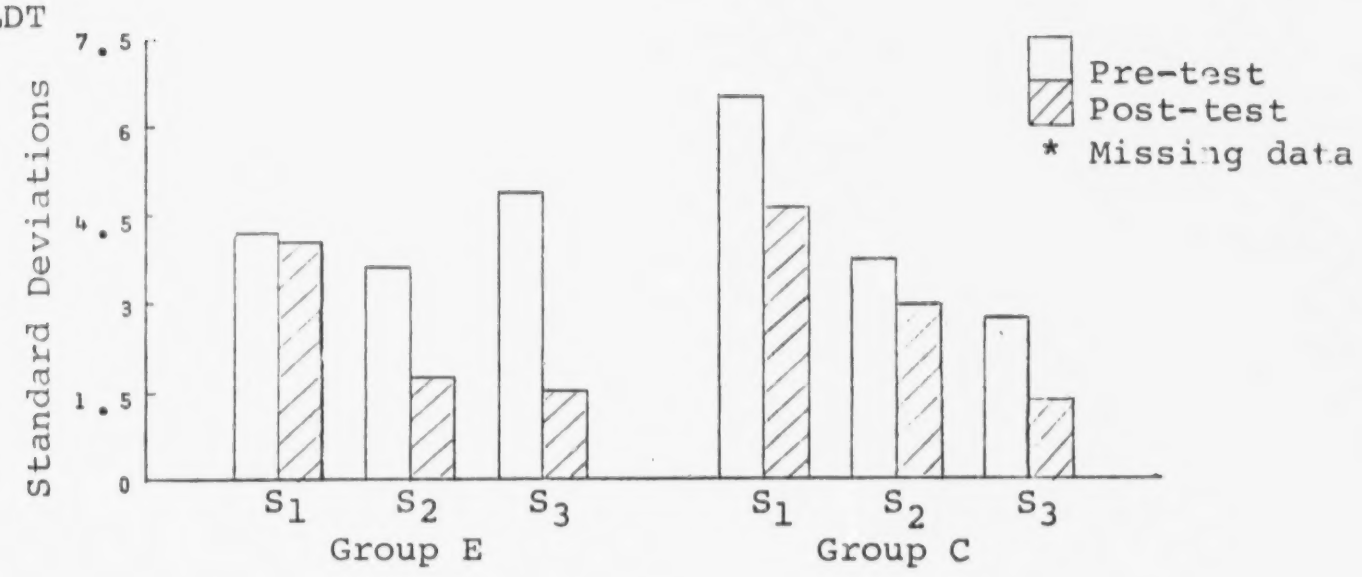
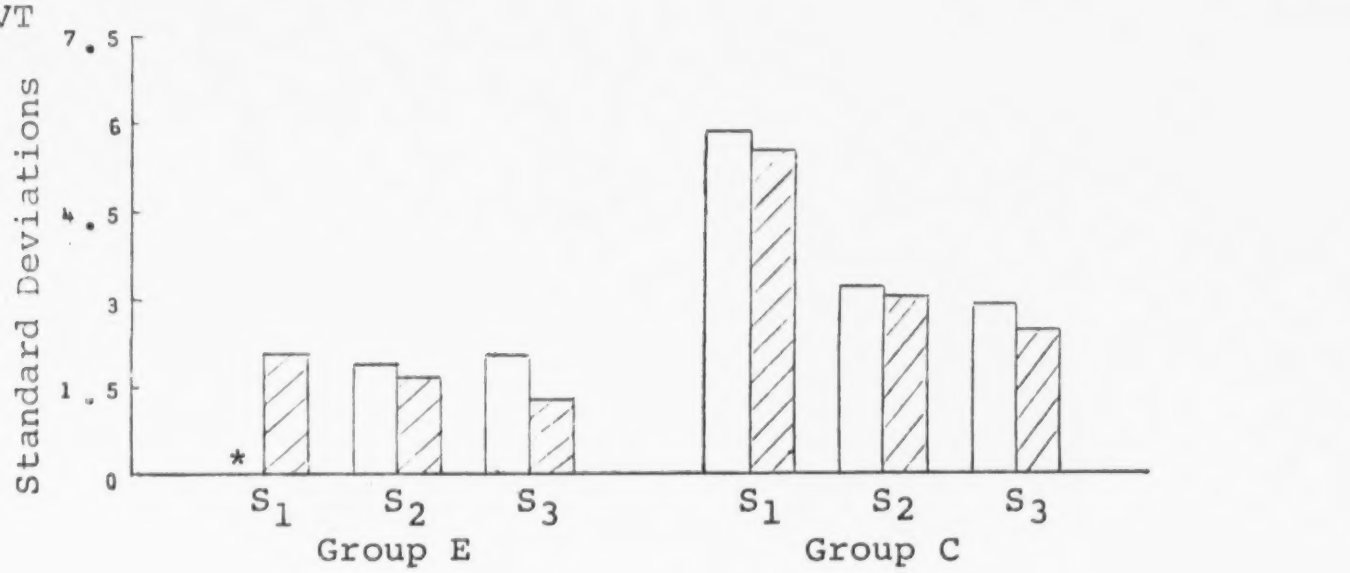


Fig. 2. Mean peak-to-peak interval (PP) for each S during pre-tests and post-tests [light detection (LDT), visual vigilance (VVT), and auditory vigilance (AVT)]. (Note: Interval distance of 5 mm. corresponds to 1 sec.).

A - LDT



B - VVT



C - AVT

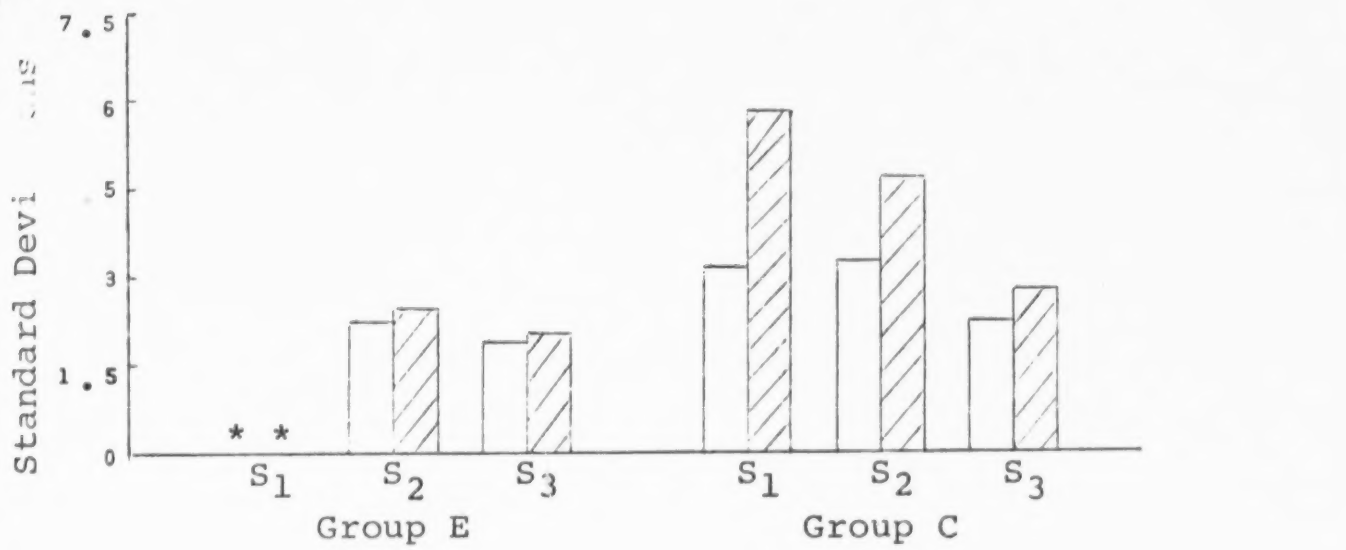


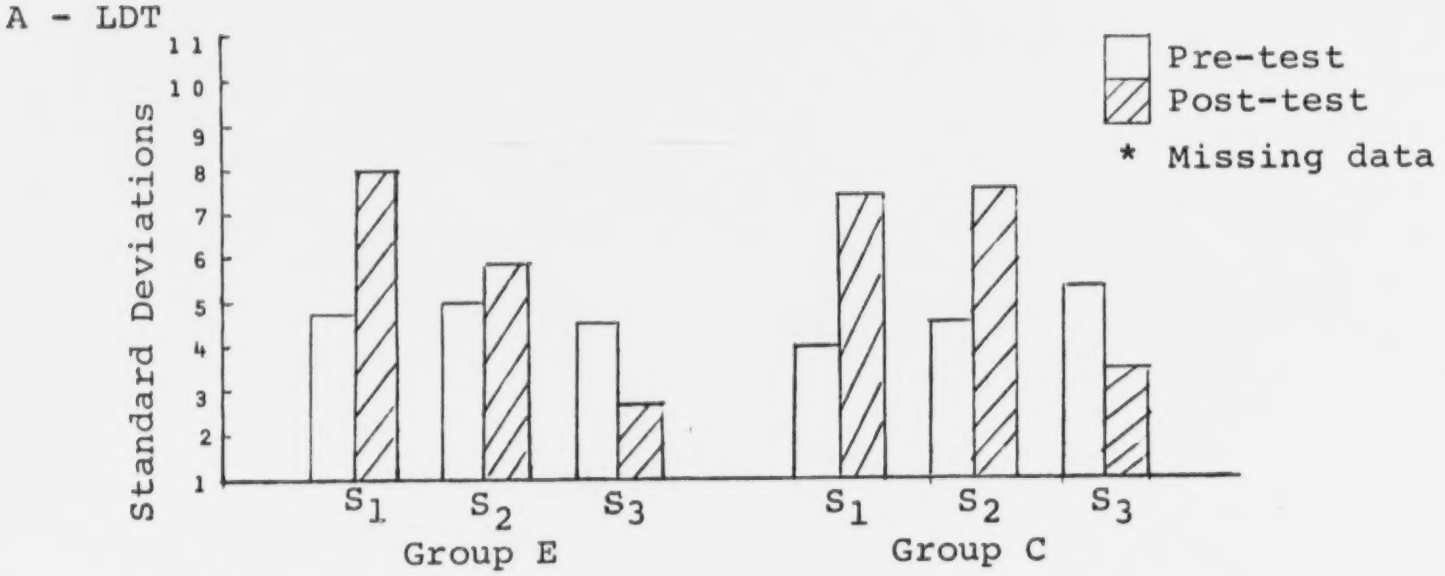
Fig. 3. Peak-to-peak variability (PP-V) for each S during pre-tests and post-tests [light detection (LDT), visual vigilance (VVT), and auditory vigilance (AVT)].

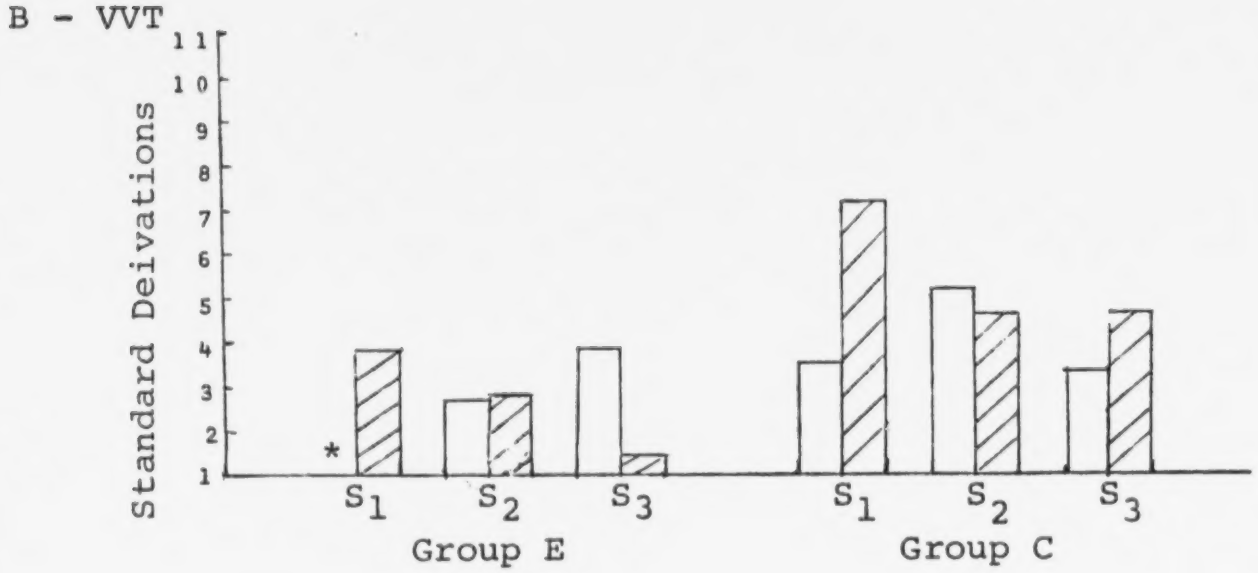
both groups appeared similar, except for the relatively slow breathing rate (large PP scores) of $\underline{S}_1$ in Group C. Figure 3 reveals that PP-V scores tended to decrease from pre-test to post-test for LDT and VVT, but increased for AVT. While the changes in variability were not greatly different for the two groups, they were generally more favorable for Group E. For instance, $\underline{S}_2$ and $\underline{S}_3$ of Group E showed only minimal increases in pre- to post-test scores for AVT (as compared to Group C) and the decreases in post-test scores for LDT and VVT were generally as large or larger than those for Group C.

The variability of inspiration-amplitude (IA-V) scores is presented in Figure 4. It is noted that except for $\underline{S}_3$ in Group E, the general tendency in both groups was for scores to increase from pre-test to post-test. The scores for RI are shown in Figure 5 and it is observed that the scores generally decreased from pre-test to post-test, particularly for Group E.

Story-reading periods. Respiration measures obtained during story-readings throughout the training phases are illustrated in Figures 6-9. Weeks 2-5 and 9-11 are included and it is noted that training in Weeks 2-5 involved respiration tracking (for Group E) and Weeks 9-11 entailed generalization training.

Figure 6 shows mean respiration peak-to-peak intervals (PP) for each $\underline{S}$. The variability of peak-to-peak intervals (PP-V) is presented in Figure 7. It is observed that all three $\underline{S}$s in Group E decreased in breathing-period variability from Week 2 to Week 3, as opposed to only one $\underline{S}$ in Group C. The trend toward consistently low PP-V scores for Group E continued in later sessions





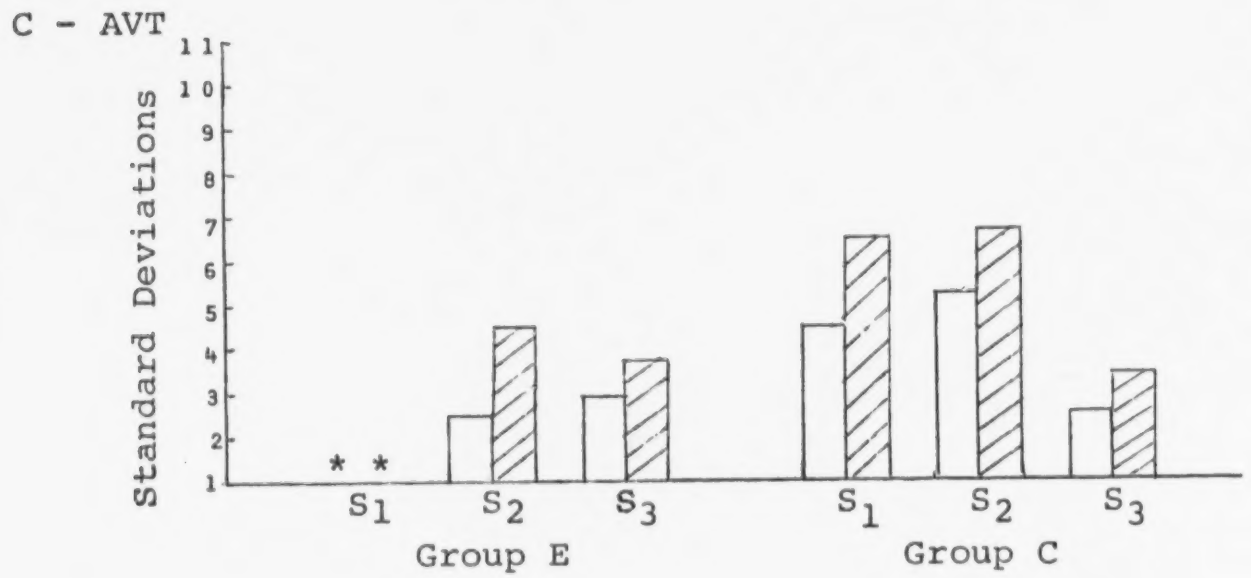
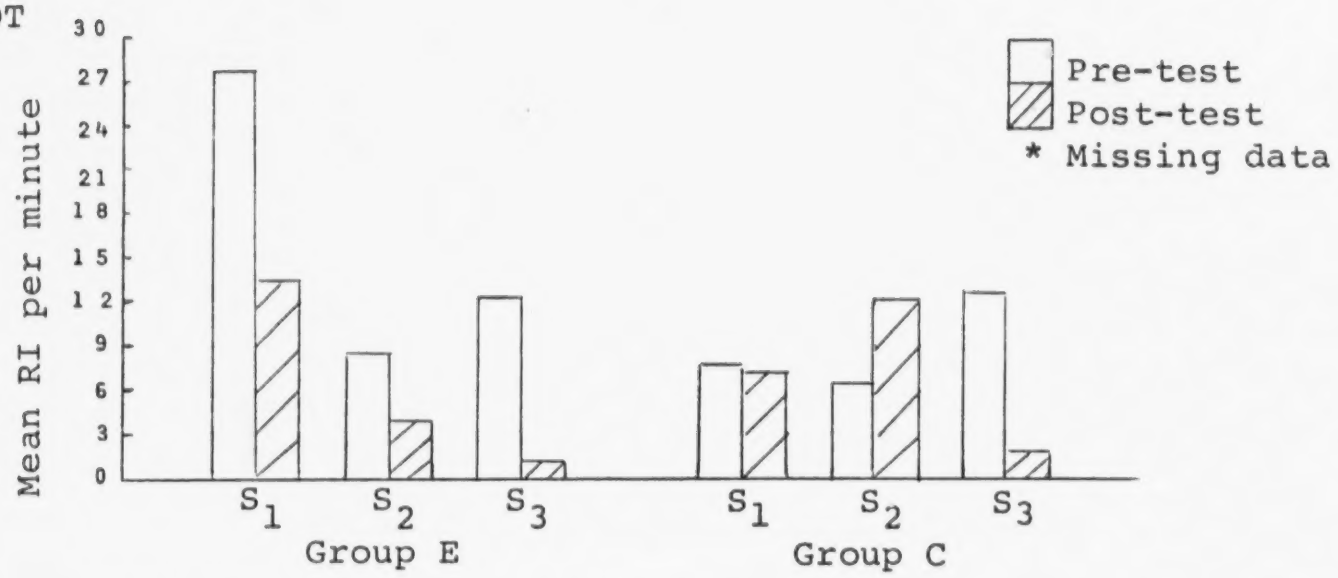
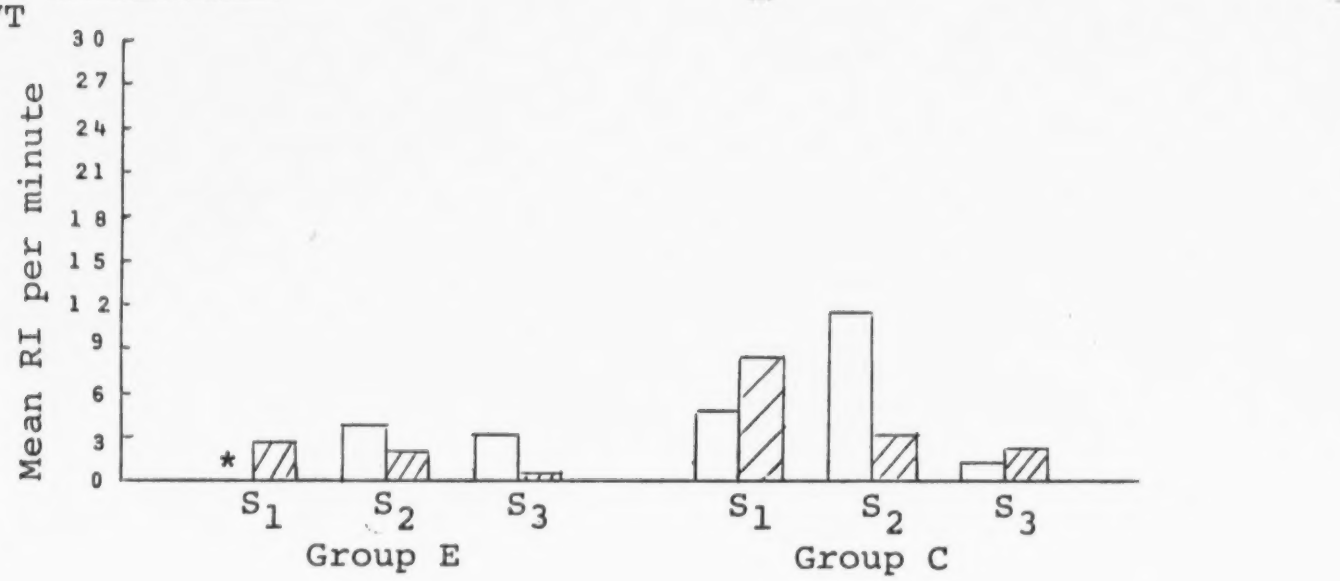


Fig. 4. Inspiration-amplitude variability (IA-V) for each S during pre-tests and post-tests [light detection (LDT), visual vigilance (VVT), and auditory vigilance (AVT)].

A - LDT



B - VVT



C - AVT

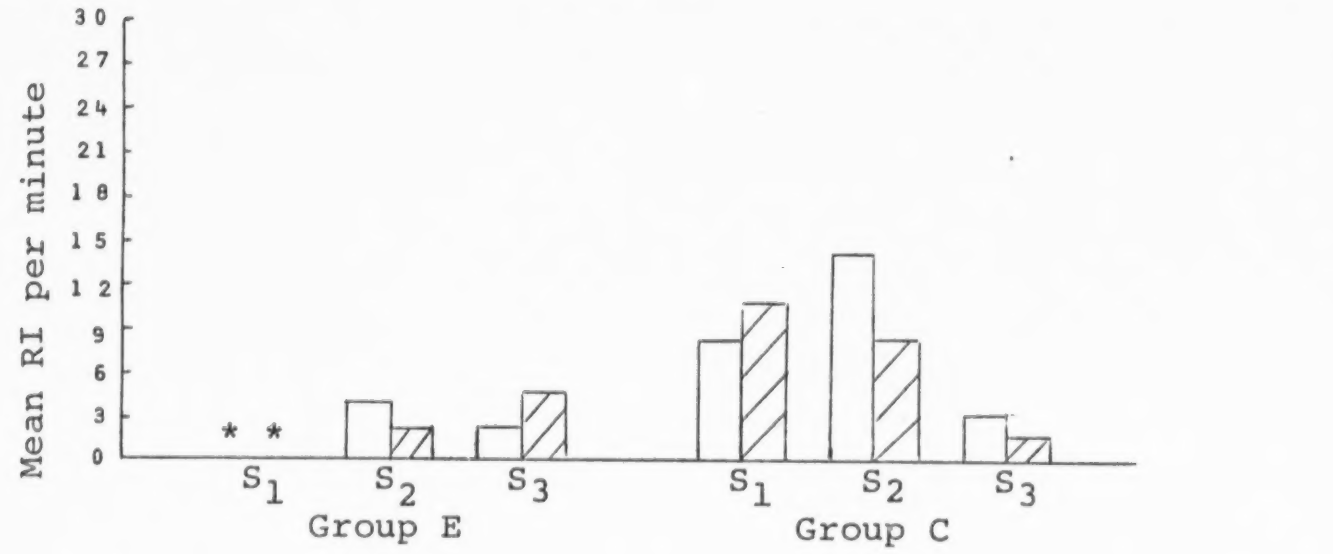


Fig. 5. Mean respiration record irregularities (RI) per minute for each S during pre-tests and post-tests [light detection (LDT), auditory vigilance (AVT), and visual vigilance (VVT)].

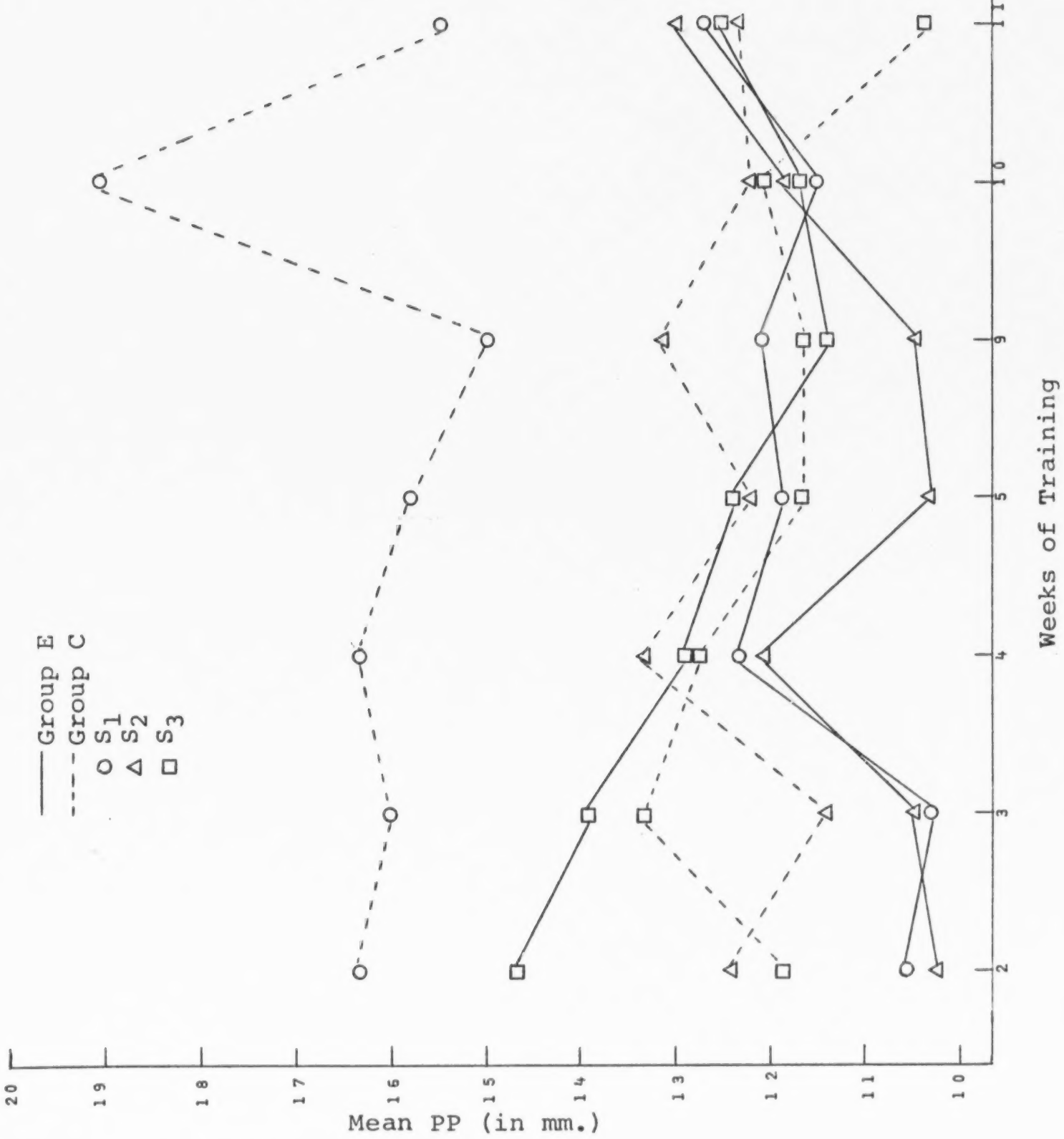


Fig. 6. Mean respiration peak-to-peak intervals (PP) for each S during story-reading periods. (Note: Interval distance of 5 mm. corresponds to 1 sec.).

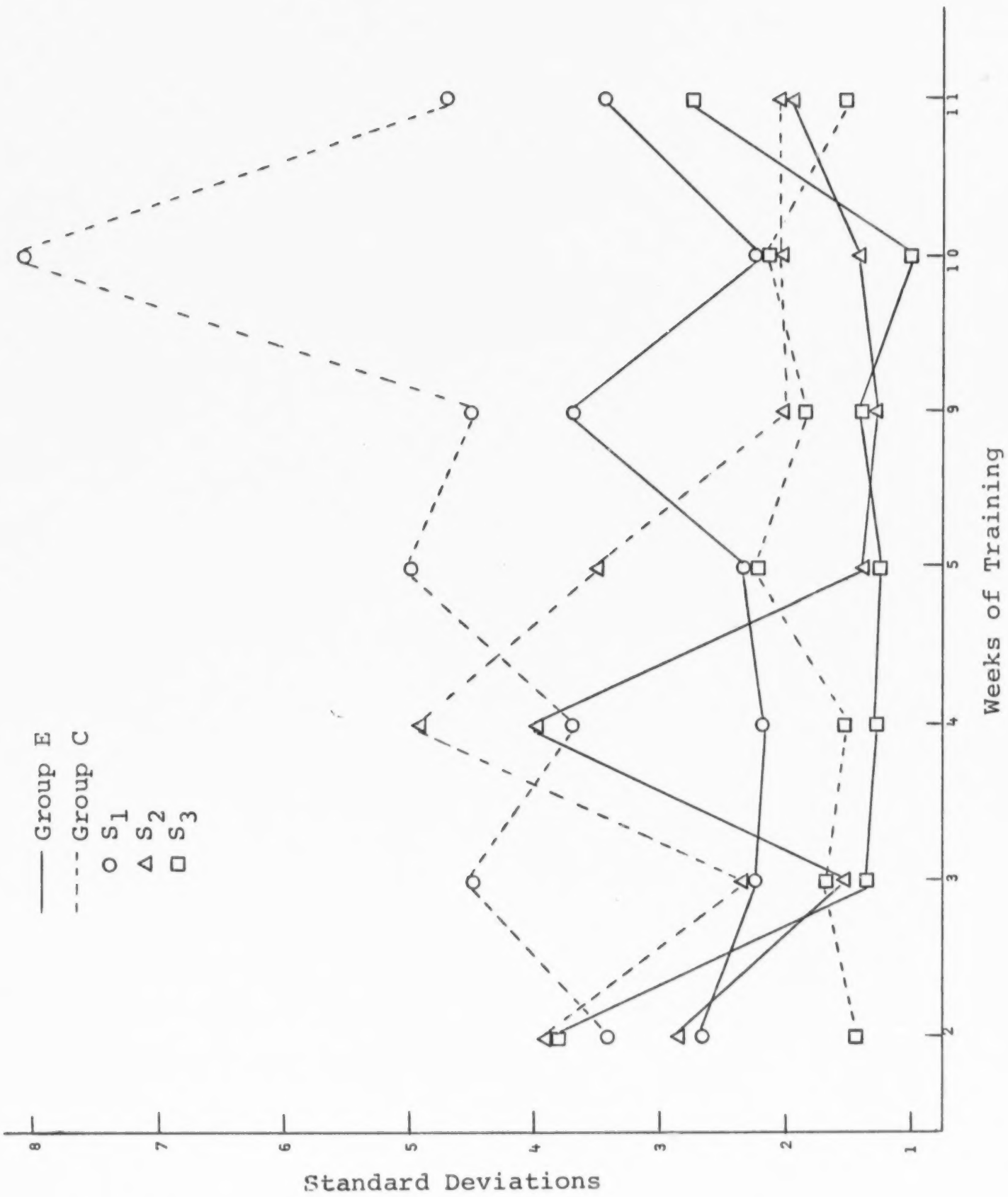


Fig. 7. Mean respiration peak-to-peak variability (PP-V) for each S during story-reading periods.

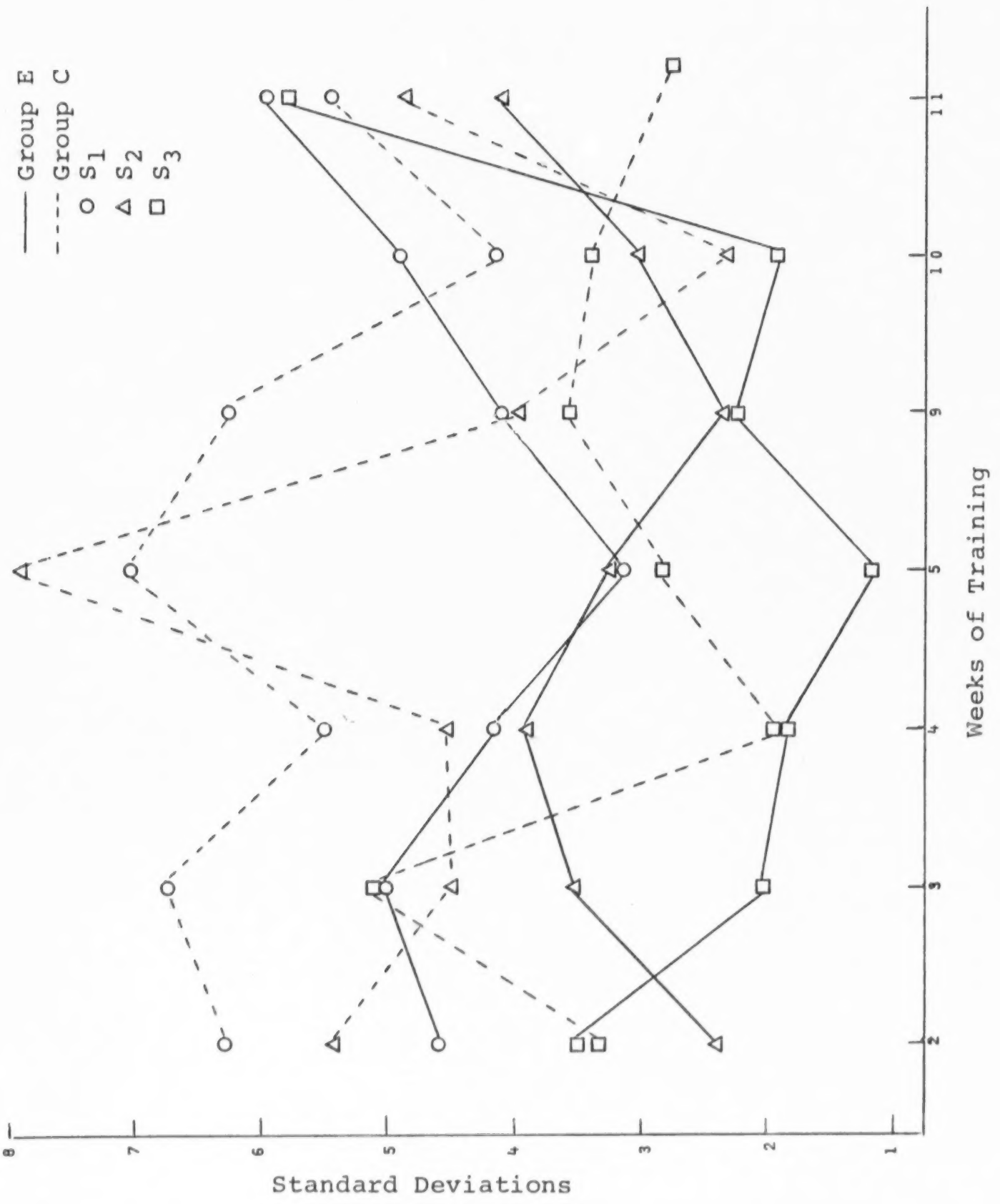


Fig. 8. Mean inspiration-amplitude variability (IA-V) for each S during story-reading periods.

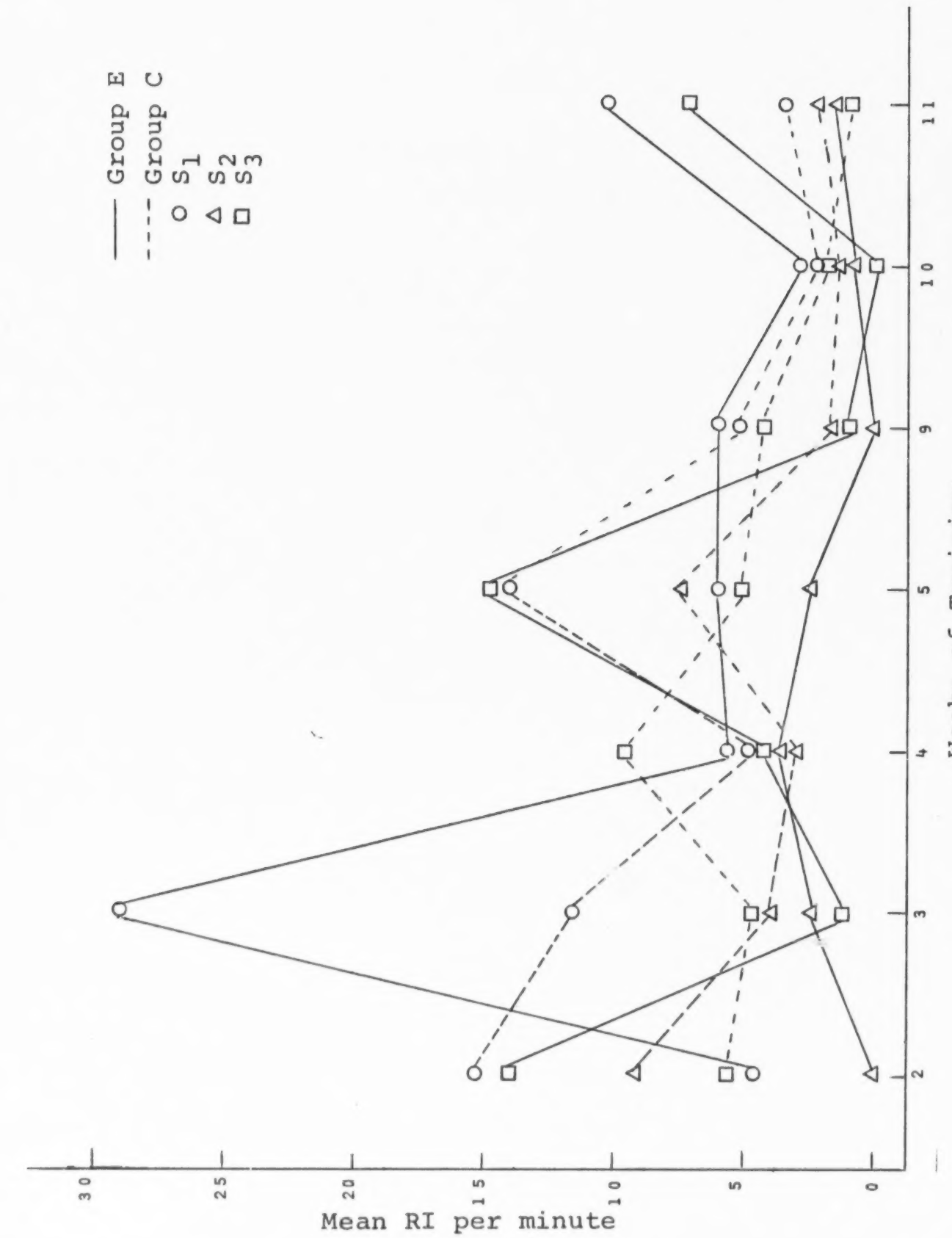


Fig. 9. Mean respiration record irregularities (RI) per minute for each S during story-reading periods.

and was particularly evident in Weeks 2-5, before generalization training began. One major exception to this trend was in Week 4 when $\underline{S}_2$ of Group E did not receive his regular medication and showed a high degree of hyperactive behavior throughout the session.

The inspiration-amplitude variability (IA-V) scores are shown in Figure 8. During Weeks 2-5 there was a general tendency for Ss from Group E to decrease in breathing-depth variability, while the scores for Group C showed large fluctuations and no consistent trend. Again, $\underline{S}_2$ was an exception in Group E in that his scores increased until Week 4 and then decreased. Scores during the generalization training (Weeks 9-11), however, tended to increase for the Ss in Group E and remained high and unstable for Group C. The scores for respiration irregularities (RI) are presented in Figure 9 and it is observed that on most occasions, low scores involve $\underline{S}_2$ and $\underline{S}_3$ of Group E.

Performance Scores

Changes in performance between pre-tests and post-tests differed considerably between individuals but showed no consistent relationship between groups. Table 1 shows pre-test, post-test, and change scores (in terms of proportion correct) for the individual Ss in each group for the tests of attention and vigilance. Due to excessive hyperactivity and movement out of the test area, the pre-test for the visual vigilance test (VVT) and the pre- and post-tests for the auditory vigilance test (AVT) were aborted for $\underline{S}_1$ of Group E. The remaining S's scores for VVT and AVT are

TABLE 1

Pre-test, Post-test, and Change (Δ) in Attention Measures for Proportion of Items Correct

	VDT			LDT			VVT			AVT		
	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
Group E												
S_1	.60	.60	0	.56	.82	.26	*	.95	-	*	*	-
S_2	.64	.60	-.04	.98	1.0	.02	.99	1.0	.01	1.0	1.0	0
S_3	.66	.80	.14	.84	1.0	.16	.99	.99	0	.99	1.0	.01
Group C												
S_1	.56	.66	.10	.74	.90	.16	.96	.96	0	.99	1.0	.01
S_2	.62	.74	.12	.98	.98	0	.98	1.0	.02	1.0	1.0	0
S_3	.56	.86	.30	.94	1.0	.06	.99	1.0	.01	.86	.99	.13

*No score (test aborted)

observed to be extremely high and thus provided for little or no opportunity for improvements. A similar problem was also encountered for some Ss in the light detection test (LDT), although in some respects this represented the best test employed. For instance, the Ss (S_1 in Group E and S_1 in Group C) who had the lowest LDT pre-test scores were also considered to be the poorest performers in the training sessions, as indicated by the fact that they received the lowest average number of reinforcements during training. The relatively high scores by most Ss on the pre-test, however, precluded a meaningful comparison between groups with respect to change in pre-test to post-test scores. The visual discrimination test (VDT) was the only test in which scores were not near perfect and in these scores, the overall improvements tended to be in favor of Group C.

Pre-test, post-test, and change in the scaled scores for the WISC are presented in Table 2. Also included in the table are the ages (in years and months) of Ss at the time of pre-testing. Performance changes from pre- to post-testing were not consistent for groups but appeared to favor Group E for the coding and maze tests and Group C for the others.

Behavior Ratings

The S ratings performed by teachers at Starpoint School using the Student Behavior Scale (see Appendix A) generally reflected behavioral improvements throughout the duration of the study, but they appeared to show little consistent relationship with the training differences between the groups. The averaged ratings obtained

TABLE 2

Pre-test, Post-test, and Change (Δ) in WISC Scaled Scores

	Age at Pre-test	Digit Span			Picture Arrangement			Block Design			Coding			Mazes		
		Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
Group E																
S_1	7-6	6	6	0	6	5	-1	7	8	+1	4	7	+3	5	8	+3
S_2	6-1	10	11	+1	11	11	0	12	12	0	8	14	+6	13	14	+1
S_3	6-1	11	10	-1	14	15	+1	14	11	-3	8	8	0	10	15	+5
Group C																
S_1	7-3	8	7	-1	9	15	+6	9	10	+1	13	10	-3	11	10	-1
S_2	7-2	9	12	+3	14	20	+6	15	14	-1	8	10	+2	14	14	0
S_3	8-1	7	13	+6	10	13	+3	11	16	+5	18	18	0	13	12	-1

from the two teachers who worked closely with the Ss were used in the following illustrations of three items taken from the rating scale. Ratings taken throughout the study (before and after training, and at bi-weekly intervals in between) are shown for each S individually. Figure 10 presents the mean ratings for hyperactivity (Item 2 in the Student Behavior Scale), Figure 11 (Item 24) for inattentiveness, and Figure 12 (Item 39) for distractability. The most prominent rating change on each of the three items involved S_3 of Group C, who was started on drug medication during the seventh week of training. Although favorable trends for Group E appear to emerge in some of the ratings, as in the case of hyperactivity, these trends are slight and remain speculative.

Discussion

The results provided qualified support for the effectiveness and feasibility of the proposed training procedure for the self-control of hyperactive behavior in children. In comparison to the control group, the children given breathing control and attention training tended to show more favorable changes from pre-test to post-test periods and throughout training in terms of irregularities associated with breathing periodicity and depth. Success in breathing control, however, varied among the three children (in Group E) as reflected by the amount of tracking error during the early sessions of training (see Figure 1). One child (S_3) quickly became very adept at controlling breathing and clearly understood the association between regulated respiration and

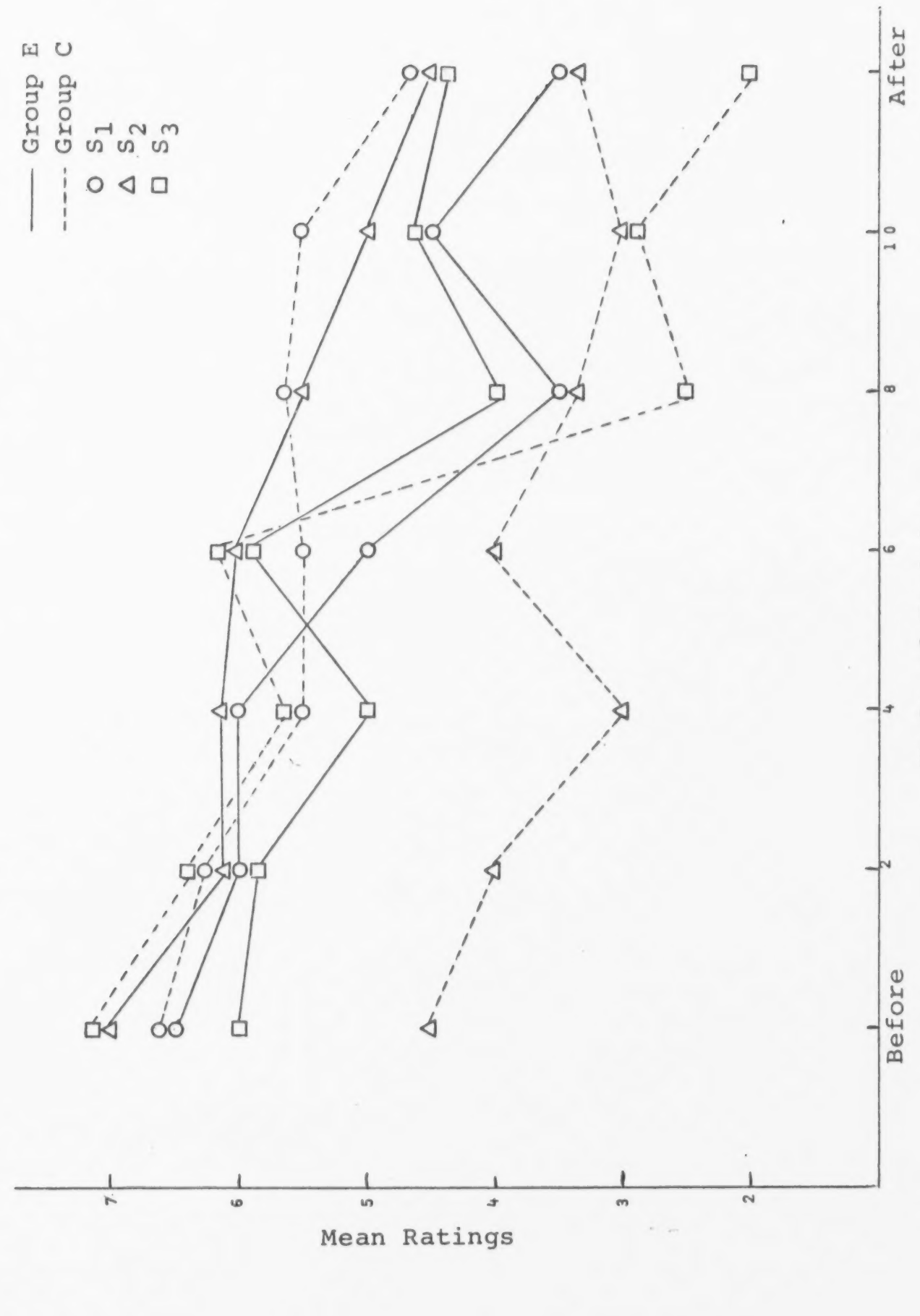


Fig. 10. Mean ratings of hyperactivity by teachers before, during, and after training.

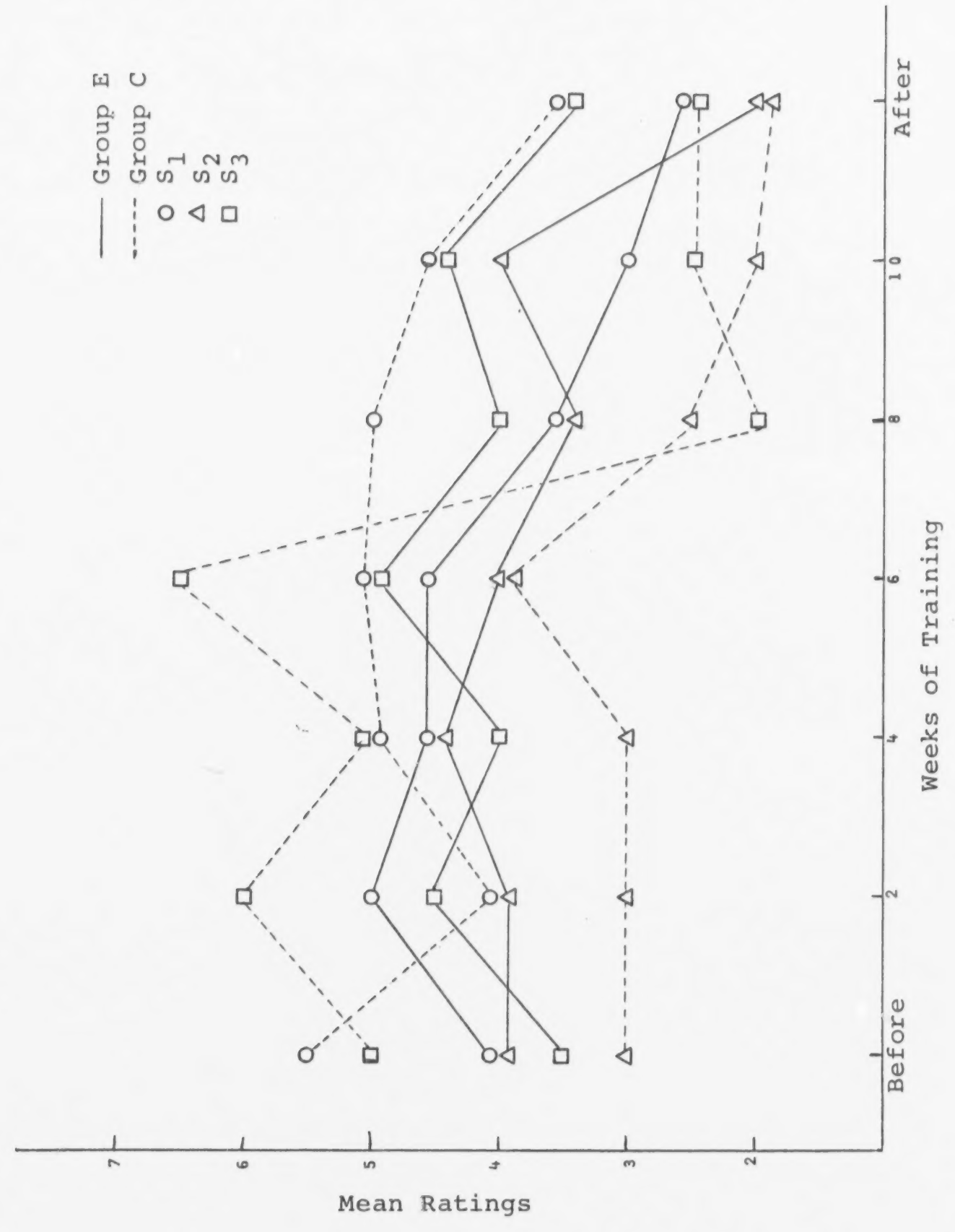


Fig. 11. Mean ratings of inattentiveness by teachers before, during, and after training.

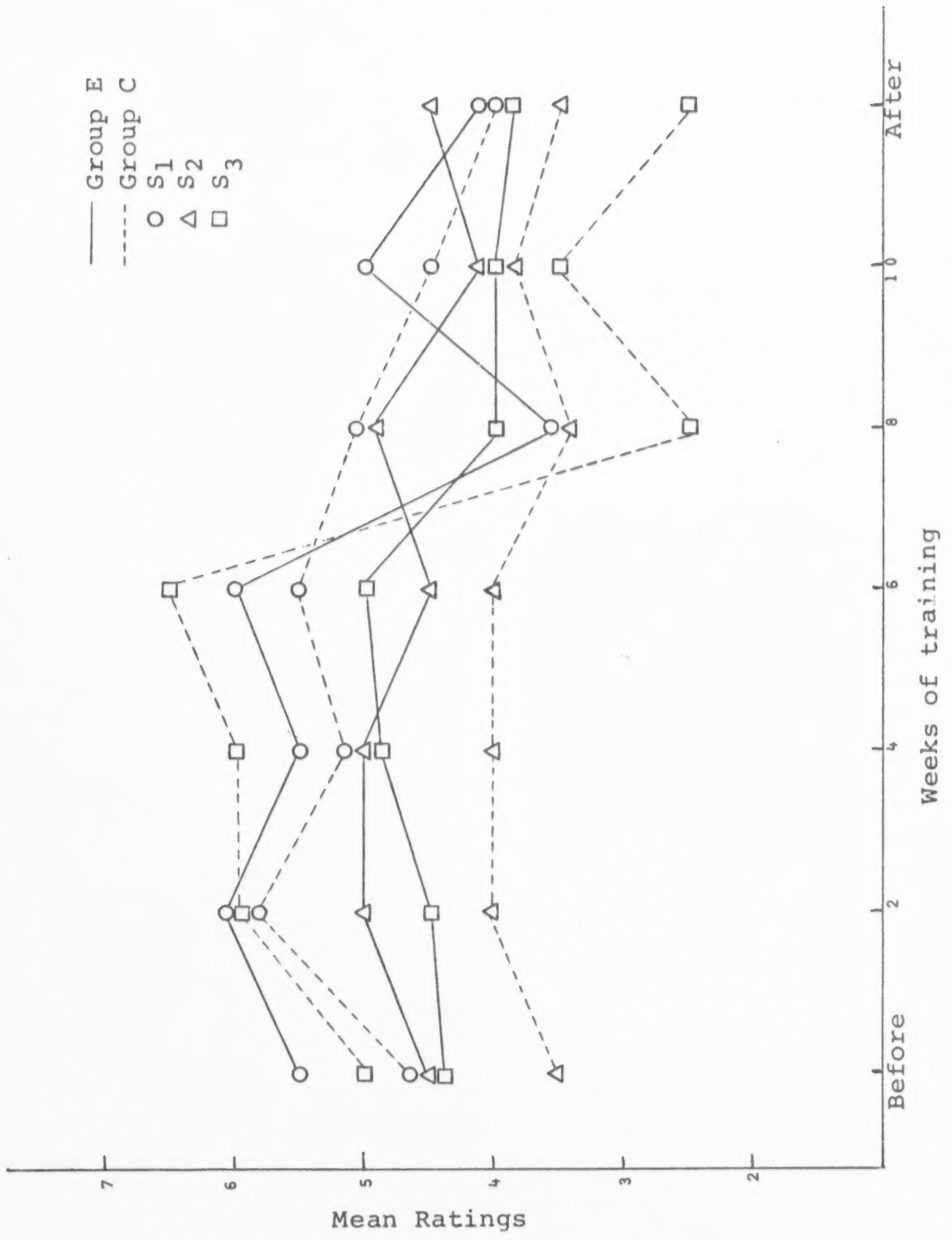


Fig. 12. Mean ratings of distractibility by teachers before, during, and after training.

reinforcement. At the same time, another child (S_1) had much more difficulty in regulating his breathing. It should be pointed out, however, that this child exhibited some evidence of cerebral palsy, although not professionally diagnosed as such. His scores on the WISC subscales were the lowest of all children in the study, he was the only child incapable of completing the attention and vigilance tests, and he exhibited poor motor coordination.

While the overall differences between the two groups included in the present study were not great, they should be regarded as conservative estimates of the effects of breathing control training. The children in the control group were rewarded for performing satisfactorily in the training tasks given, and thus, in effect, for attending and controlling excessive behaviors. Reinforced behaviors, therefore, were similar for both groups. Furthermore, it was not possible to prevent discussions between members of different groups and the amount of information exchange between groups regarding training procedures was not known. During discussions with the children at the end of the study, however, one child in the control group expressed the notion that because the respiration sensors were always used, his reinforcements were probably associated with his breathing as well as maintaining attention.

Breathing control and attention training appeared to be a promising approach to the self-control of behavior as it was observed in the training setting, but the control was not generally transferred to other settings, such as the classroom. For instance, the difference in behavior control exhibited in the training room as compared to the classroom was usually quite large, with much

more overt hyperactivity shown when the child was not in the training setting. This observation was supported by the comments of instructors from Starpoint School who also observed the children in the training room. Although generalization of the training appeared to be limited, one exception was noted by an instructor in that on one occasion a child (from Group E) verbally commented on his use of breathing control during a writing lesson in a regular class period.

Transfer of training effects is an extremely significant aspect of procedures such as those proposed herein, but the limited scope of the present study precluded substantial generalization training. To enhance the generalization effect, it is considered important that emphasis should be extended to reinforced training in the classroom or other learning settings. In other words, as training progresses, it should be incorporated as much as possible into the actual learning situation. While the transfer of breathing control in the present study was limited, an encouraging observation was the tendency for $\underline{S}_2$ and $\underline{S}_3$ of Group E to maintain the most regulated breathing patterns of all children during story-reading periods in the training setting, while no reinforcements were being provided. It is noted, however, that since the measures during pre-tests (before training began) for these children were also relatively low, the breathing control cannot be attributed entirely to training effects and the trend must therefore be interpreted cautiously.

Methods for assessment of training effects on tests of attention and vigilance in the present study were generally unsuccessful.

The tests were designed on the basis of those used in previous research, but test scores for the children were typically near perfect which precluded effective measurement of improvements associated with training. The use of similar tests in future research, therefore, should be based upon more extensive pilot work and test development.

Medication was not included as a controlled variable in this study, but it appeared to be an important factor to consider in evaluating the results. Two children were given no medication during the study ($\underline{S}_1$ in Group E, and $\underline{S}_2$ in Group C) and two children were on ritalin throughout its duration ($\underline{S}_2$ in Group E, and $\underline{S}_1$ in Group C). In reference to the teacher ratings of hyperactivity in the classroom (see Figure 10), it was judged that the latter two children remained the most hyperkinetic throughout the study. Without regular medication, $\underline{S}_2$ in Group E was observed to become particularly disruptive both in the regular classroom as well as in the training setting.

By coincidence, medication was begun for both of the remaining children ($\underline{S}_3$ in Group E, and $\underline{S}_3$ in group C) during the seventh week of training. The child in Group E was given dexedrine, but in the opinion of Starpoint School instructors it had little effect on his behavior. The effect of medication for the other child ($\underline{S}_3$ in Group C) appeared to be much more dramatic. He was given ritalin and the behavior ratings (Figures 10-12) reflected marked improvements during the remainder of the study. The improvements from pre-test to post-test performance scores (see Tables 1 and 2) were also generally larger for this child.

Conclusions

The present study was a preliminary evaluation of a training approach for control of hyperactive behavior. The method involved breathing control and attention training which incorporated the use of biofeedback and operant conditioning principles for the purpose of training children in the self-control of attention and excessive or distracting motor behaviors in learning situations. It appeared to provide a feasible and effective means of behavior control for children and should be considered for further examination.

This study has provided a basis for improving the training and assessment procedures of future research of this nature. In particular, experience obtained in the present research suggests that training could be improved by increasing the flexibility and individualization of the training schedule for each child, taking into account his specific behavioral and learning problems. The training should also be incorporated as much as possible into the learning setting itself in order to achieve more efficiency in transferring the training effects for behavior control. The use of respiration recordings as a monitor to reflect the general behavior pattern and as a basis of reinforcement during training appeared to be rather effective. More work needs to be done, however, for more effective and efficient quantification of breathing parameters (such as irregularity measures) for use in training.

With refinements in the training procedure, the proposed technique for controlling hyperactive behavior by children is regarded as applicable and feasible. Further study is necessary, however, before a thorough evaluation of the approach can be made.

REFERENCES

Christopherson, E. R. & Arnold, C. M. Behavior modification program for parents of children with behavior problems. Proceedings, 79th Annual Convention, APA, 1971, 665-666.

Clements, S. D. Minimal brain dysfunction in children: Terminology and identification, phase one of a three-phase project. Washington, D.C.: U. S. Department of Health Education and Welfare, 1966. NINDB Monograph No. 3.

Cobb, J. A., Ray, R. S. & Patterson, G. R. Direct intervention in the schools. Journal of School Psychology, 1971.

Freedman, D. X. (Chairman) Report of the conference on the use of stimulant drugs in the treatment of behaviorally disturbed young school children. Washington, D.C.: U. S. Department of Health, Education and Welfare, January 11-12, 1971.

Grossberg, J. Behavior therapy: A review. Psychological Bulletin, 1964, 62, 73-88.

Hall, R. V., Axelrod, S., Tyler, L., Grief, E., Jones, F. C. & Robertson, R. Modification of behavior problems in the home with parent as observer and experimenter. Proceedings, 79th Annual Convention, APA, 1971, 669-670.

Haring, N. G. (Ed.) Minimal brain dysfunction in children. Public Health Service Publication #2015. Washington, D.C.: U. S. Department of Health, Education and Welfare, 1969.

Johnson, S. M. Effects of self-reinforcement and external reinforcement and external reinforcement in behavior modification. Proceedings of the 77th Annual Convention of the American Psychological Association, 1969, 4 (Pt. 2), 535-536.

Kagen, J. Reflection-impulsivity and reading ability in primary grade children. Child Development, 1965, 36, 609-628.

Keogh, B. K. Hyperactivity and learning disorders: Review and speculation. Exceptional Children, 1971, 38, 101-109.

Millichap, J. G. Drugs in management of hyperkinetic and perceptually handicapped children. Journal of the American Medical Association, 1968, 206, 1527-1530.

Millichap, J. G., Aymot, F., Sturgis, L. H., Larsen, K. W. & Egan, R. A. Hyperkinetic behavior and learning disorders. III. Battery of neuropsychological tests in controlled trial of methylphenidate. American Journal of Diseases of Children, 1968, 116, 235-244.

Myklebust, H. R. & Boshes, B. Minimal brain damage in children. Washington, D. C.: U. S. Department of Health, Education and Welfare, 1969.

O'Leary, K. D. & Drabman, R. Token reinforcement programs in the classroom: A review. Psychological Bulletin, 1971, 75, 379-398.

Patterson, G. R., Jones, R., Whittier, J. & Wright, M. A. A behavior modification technique for the hyperactive child. Behavior Research and Therapy, 1965, 2, 217-226.

Schulman, J. L., Kasper, J. C. & Throne, F. M. Brain damage and behavior: A clinical experimental study. Springfield Ill.: Thomas, 1965.

Schultz, J. H. & Luthe, W. Autogenic training: A psychophysiological approach in psychotherapy. New York: Grune and Stratton, 1959.

Skinner, B. F. Operant behavior. American Psychologist, 1963, 18, 503-515.

Ullman, L. P. & Krasner, L. (Eds.) Case studies in behavior modification. New York: Holt, Rinehart & Winston, 1965.

Walken, C. L. Accelerating classroom attending behaviors and learning rate. Dissertation Abstracts International, 1969, 30, 1032.

Woodworth, R. S. & Schlosberg, H. Experimental psychology. New York: Holt and Co., 1954.

Wunderlich, R. C. Hyperkinetic disease. Academic Therapy, 1969-1970, 5, 99-108.

APPENDIX A

STUDENT BEHAVIOR SCALE (SBS)

Teacher:_____ Student:_____

Date:_____

Circle the number most representing the behavior or development at this time, referring to your norm profiles, if necessary.

GENERAL BEHAVIOR	maximum						minimum
1) Emotional lability	7	6	5	4	3	2	1
2) Hyperactivity	7	6	5	4	3	2	1
3) Impulsivity	7	6	5	4	3	2	1
4) Bodily complaints	7	6	5	4	3	2	1
5) Tics	7	6	5	4	3	2	1
6) Tremors	7	6	5	4	3	2	1
7) Irritability	7	6	5	4	3	2	1
8) Seizures	7	6	5	4	3	2	1
9) Motor incoordination	7	6	5	4	3	2	1
10) Oral fixations	7	6	5	4	3	2	1
11) Dependency	7	6	5	4	3	2	1
12) Immaturity	7	6	5	4	3	2	1
13) Compulsive talkativeness	7	6	5	4	3	2	1
14) Aggressiveness	7	6	5	4	3	2	1
15) Frustration intolerance	7	6	5	4	3	2	1
16) Emotional uninvolvement	7	6	5	4	3	2	1
17) Withdrawal	7	6	5	4	3	2	1
CLASSROOM BEHAVIOR							
18) Sits fiddling with small objects	7	6	5	4	3	2	1
19) Hums and makes odd noises	7	6	5	4	3	2	1
20) Falls apart under stress of examination	7	6	5	4	3	2	1
21) Fine motor incoordination	7	6	5	4	3	2	1
22) Restless or overactive	7	6	5	4	3	2	1

52
2

STUDENT BEHAVIOR SCALE (SBS)

	maximum						minimum
23) Excitable	7	6	5	4	3	2	1
24) Inattentive	7	6	5	4	3	2	1
25) Difficulty in concentrating	7	6	5	4	3	2	1
26) Daydreams	7	6	5	4	3	2	1
27) Disturbs other children	7	6	5	4	3	2	1
28) Temper outbursts	7	6	5	4	3	2	1
29) Poor posture at desk	7	6	5	4	3	2	1
30) Uncontrolled voice volume	7	6	5	4	3	2	1
31) Unacceptance of suggestions for modifying behavior	7	6	5	4	3	2	1
GROUP BEHAVIOR							
32) Isolates himself from other children	7	6	5	4	3	2	1
33) Appears to be unaccepted by group	7	6	5	4	3	2	1
34) Teases other children	7	6	5	4	3	2	1
35) Interfers with others' activities	7	6	5	4	3	2	1
ACADEMIC BEHAVIOR							
36) Poor attention span	7	6	5	4	3	2	1
37) Attention lability	7	6	5	4	3	2	1
38) Attention perseveration	7	6	5	4	3	2	1
39) Distractibility	7	6	5	4	3	2	1
40) Task perseveration	7	6	5	4	3	2	1
41) Task incompletion	7	6	5	4	3	2	1
42) Auditory inacuity	7	6	5	4	3	2	1
43) Verbal inadequacy	7	6	5	4	3	2	1
44) Intellectual inefficiency	7	6	5	4	3	2	1
45) Memory inadequacy	7	6	5	4	3	2	1

Comments: